DESIGN CONDITIONS FOR INDIA & COMPUTER PROGRAMS
For
AIR-CONDITIONING LOAD CALCULATIONS

A THESIS SUBMITTED

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CERTIFICATE

This is to certify that the work "Design conditions for India a computer program for air conditioning load calculation" by Dilip Kohli has been carried out under our supervision and has not been submitted elsewhere for a degree.

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- Dilip Kohli

ABSTRACT

A numerical procedure using Newton-Raphson technique is used for finding wet bulb temperature from observed dry bulb temperature relative humidity and barometric pressure. Assuming maximum temperatures and daily temperature ranges of the day as random variables, maximum temperatures and daily ranges are estimated from samples of ten years data by t-distribution for various confidence limits. A parameter called "Average Hourly Temperature Deviation" is defined and its effect on Equivalent temperature differential is demonstrated. A mathematical model for finding out optimum daily temperature distribution has been developed. An average value of the above parameter is chown as the optimality criterion. Computer programs for system design calculations have been developed.

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LIST OF FIGURES

NOMENCLATURE

p_s^*	Water vapour pressure for saturated air
$c_{p_a}^*$	Specific heat of dry air
h_g^*	Enthalpy of saturated water vapour
h_w^*	Enthalpy of condensed water
w_s^*	Humidity ratio for saturated air at wet bulb temperature t^*
p_s'	Saturated vapour pressure
t_{db}	Dry bulb temperature
t_{wb}	Wet Bulb temperature
m_a	rate of exchange of dry air
m_w	rate of moisture transfer
w_o	Humidity ratio of outdoor air
w_i	Humidity ratio of indoor air
$T_{o_{max}}$	Maximum outside temperature of the day
T_h	Hourly outside temperature
$T_{max.p}$	Value of maximum temperature for p confidence limit
D_t	Hourly temperature differential
T_t	Temperature at any hour t
T_{min}	Minimum temperature of the day
a_N	Coefficient of harmonic series
b_N	Coefficient of harmonic series
H_{max}	Most likely time of maximum temperature of the day
H_{min}	Most likely time of minimum temperature of the day
I_t	Total radiation
IDN	Normal Irradiation

I_λ	Monochromatic direct radiation
I_D	Direct solar radiation
I_d	Diffused solar radiation
I_R	Reflected solar radiation
h_o	Outside heat transfer coefficient
h_i	Inside heat transfer coefficient
t_o	Outside ambient temperature
t_i	Inside ambient temperature
q_o	Rate of heat transfer from the external thermal environment
$t_{w,o}$	Temperature of outside surface
I	Combined incidence of solar radiation
t_e	Sol-air temperature
T_e	Sol-air temperature expressed by Fourier series
T_{e,m_n} T_{e,n_n}	Coefficients of Fourier series in sol-air temperature expression
W_n	Angular frequency in n^{th} harmonic
t_w	Temperature of the wall
k_w	Thermal conductivity of wall
t^*	Thermodynamic wet bulb temperature
W	Humidity ratio for moist air at prevailing dry bulb and wet bulb temperatures
p'	Barometric pressure
q	Rate of heat transfer in btu/hr
P	Probability
N	Number of harmonic

t	Time
l	Latitude
d	Declination
h	Hour angle
A	Apparent solar irradiation at air mass = 0
B	Atmospheric extinction coefficient
C	Diffused radiation coefficient
r	Fraction reflected after incidence
n	Index of refration
ϕ	Relative humidity
σ_{av}	Average hourly temperature deviation
ν	Degrees of freedom
ω	Angular frequency
λ_1 λ_2 λ_3	Lagrangian multipliers
γ	Azimuth angle
θ	Incidence angle
ψ	Zenith angle
β	Altitude angle
α	Wall solar azimuth angle
ρ_λ	Monochromatic reflectivity
α_λ	Monochromatic absorbtivity
τ_D	Transmissivity of glass [1] (Direct solar radiation)
α_D	Absorbtivity of glass (Direct solar radiation)

τ_d Diffused solar radiation transmissivity of glass

α_d Diffused solar radiation absorptivity of glass

τ_R Reflected solar radiation transmissivity

ΔT_{EQ} Equivalent temperature difference

CHAPTER 1

INTRODUCTION

1.1 Design Conditions and Cooling Loads

The first step in the design of any cooling system is the estimation of air-conditioning cooling load. To a very great extent initial cost, operating cost and performance of system will depend upon these calculations.

The accuracy of cooling loads depends upon the accuracy of several factors used in their calculations. More important of these factors are the difference between inside and outside temperatures, solar heat gain through the structure and heat transmission coefficients for various parts of structure.

To be consistent the several factors used in calculations of heat loads should be selected with an accuracy proportional to their relative effect upon the final results.

Typically an error of 10% in heat transmission coefficient for walls, ceilings or infiltration will result in less than 3% error in total loads; whereas an error of 10% in design temperatures might result in nearly equal percentage of error in total equipment load. Hence the importance of establishing accurate design conditions can hardly be overemphasized.

The outdoor design conditions must be specified such that the designer has the opportunity to use his judgement

in selecting the appropriate outdoor conditions for the specific application. This selection is based on the tolerance (deviation) permissible with the specified indoor conditions.

The heat gain or loss is the amount of heat instantaneously coming into or going out of the space. The actual load is defined as that amount of heat which is instantaneously added or removed by the equipment. The instantaneous heat gain and the actual load on the equipment are rarely equal because of thermal inertia or storage effects of the structure.

In order to compute the cooling load it is necessary to first establish the design conditions, namely the outdoor and indoor temperature and humidity and the ventilation rate. Calculations are then carried out for the following components.

(i) Load from solar radiation, sky radiation and from outdoor indoor temperature differential for glass areas and exterior walls and roofs, modified by periodic heat flow or lag factors, depending upon the type of structure.

(ii) Load due to heat gain through interior partitions, ceilings and floors of adjoining unconditioned spaces.

(iii) Load due to heat sources within the conditioned space such as occupants, lighting, power equipment and appliances.

(iv) Load from infiltration of outdoor air.

(v) Miscellaneous heat loads.

(vi) Load from outdoor ventilation air.

Repetitive nature of load calculations suggests the development of a computer program for system loads more accurately and readily.

1.2 Present Investigation:

Present work consists of the following five parts:

(A) Computer scheme has been devised for finding wet bulb temperature from observed dry bulb temperature, relative humidity and pressure.

(B) Maximum temperatures (dry bulb and wet bulb) and ranges (Max. temperature - Minimum temperature) of a day are assumed as random variables. Maximum temperatures and daily ranges are then estimated from samples of 10 years data by t-distribution for various confidence limits.

(C) The daily variation of temperatures have been studied. It is observed that peak loads are influenced not only by the maximum temperature and daily range but also by the magnitude of values of temperatures around the maximum temperature. A new parameter called "Average hourly temperature deviation" is evolved and defined as the average (over 24 hours) deviation of hourly temperature from the maximum temperature for the day. Its influence on the peak loads and total equipment load is studied.

A mathematical model for finding out daily temperature variation has been developed. Depending upon a selected optimality criterion, corresponding to any range, an optimal

variation can be obtained. A computer program has been developed for this purpose. In view of the fact that average hourly temperature deviation plays an important role in estimation of peak loads, an average of this parameter has been chosen as the optimality criterion. The optimal variation problem has been formulated as the solution of set of simultaneous linear equations. Lagrangian Multipliers are used for introducing equality constraints. The method is deterministic and finds out exact solution for the problem formulated.

(D) Computer programmes have been developed for,

(i) calculation of equivalent temperature differential for various wall constructions, wall orientations, outside design conditions and latitudes, and

(ii) calculation of direct, diffuse and reflected solar radiation intensity falling on various wall orientations and latitudes.

The results obtained for cities Allahabad, Amritsar, Ahmedabad, Bombay, Delhi and Madras are presented.

(E) A computer program for calculation of systems cooling load has been developed. A new nomenclature has been evolved for feeding in building configuration parameters. Some standard tables in ASHRAE, Hand book of Fundamentals have been fed in the computer and are utilised in the calculation of the system load.

Literature survey has been presented in Chapter 2. Chapter 3 contains a detailed discussion of analytical and

numerical work. This covers the methods of data reduction; expressions for outdoor design conditions; mathematical model for computing average (for all of India) daily temperature variation as a function of daily temperature range; computation of equivalent temperature differentials for various standard constructions used in India and of solar heat gains for Indian latitudes; and utilization of above computed values in estimating cooling loads. The various computer programs, alongwith instructions for using these are presented in Chapter 4. Chapter 5 contains tabulated results and some of the computer outputs. Bibliography and nomenclature for symbols are presented in the following chapters.

CHAPTER 2

LITERATURE SURVEY

2.1 Data Reduction:

Hourly values of dry bulb temperature and relative humidity for Ist and 15th of each month (March - Sept.) for 10 years (1955-1964) for 28 stations have been collected from four Regional Meteorological centers viz. Delhi, Nagpur, Bombay and Madras[1a]. Average (for the month) hourly pressure values for the same 28 stations have been obtained from[1a] Indian Weather Review Annual Summary Part A[1b]. The average (for the month) hourly wind velocity values have also been obtained from Indian Weather Review Annual Summary Part A.[1b]

The observed data had to be first reduced to dry bulb and wet bulb temperature values and their daily ranges.

Complete thermodynamic properties of moist air have been presented by J.A. Goff and S. Gratch in 1945[11]. These are also reported in the 1967 edition of ASHRAE Guide Hand book of fundamentals[12], Chapters 6 and 21. This has been utilised by W. A. Spofford in 1969[10] for presenting a computer program for calculations of the various thermodynamic properties of moist air.

In the present work this program has been modified and Newton-Raphson technique has been applied for calculating thermodynamic wet bulb temperature from observed dry bulb

2.2 Design Conditions:

Two procedures have been discussed in the literature for establishing design conditions.

(i) Empirical adjustment of extreme temperature are recorded. The correction factor used is based on the experience of the designer with the performance of similar air conditioning systems over the past many years.

(ii) Statistical analysis of leviathan size of the past recorded data.

Most of the work for establishing reliable outdoor design conditions has been done in developed countries where huge amount of data is available on punched cards, recorded tapes or disks; the analysis of design conditions though time consuming and laborious, is nonetheless feasible. On the other hand, in India most of the meteorological centers have come up only recently and auto recorders are available at very few places, and of course data on punched cards for computer processing is out of the question.

Considerable effort was therefore invested in copying the hourly recorded data for ten years for 28 different cities from records available in four different regional centres in India.

2.3 Equivalent Temperature Differential:

Concept of sol - air temperature was first introduced by C.O. Mackey and L.T. Wright[3] in 1944. Outdoor air temperature and solar radiation intensity were assumed to be periodic and temperature of inside surface of the building was calculated for a single homogeneous material and approximate solution was found by neglecting higher order terms. Subsequently in 1946, the authors[4] gave a method to reduce composite walls and roofs to equivalent homogeneous walls and roofs.

This concept was first applied to several practical wall constructions by J.P. Stewart[5] in 1948, who introduced the parameter "Equivalent temperature differential" for calculating unsteady state heat gain through walls and roofs.

2.4 Solar Heat Gain Through Glass:

J.L. Threlkeld and R.C. Jordan in 1958 reported procedures for computing values of direct solar radiation and diffused solar radiation on clear days for various latitudes. Based on their work, empirical relations for calculating intensity of direct and diffused solar radiations as a function of angle of incidence have been published in ASHRAE Guide 1967 - Hand book of Fundamentals.

Parmelee[7] in 1945 has presented a procedure to find the xx properties of glass.

Threlkeld[2] (1962) has presented equations utilizing the x above parameters to calculate cooling loads for structures. These equations have been used in present investigation.

CHAPTER 3

ANALYTICAL AND NUMERICAL WORK

3.1 Computation of Wet Bulb Temperatures:

A computer program has been developed to calculate the wet bulb temperatures from the measured values of dry bulb temperature, relative humidity and barometric pressure by Newton Raphson iteration of wet bulb temperatures. The numerical calculations are based on the following relationships.

Vapour Pressure[11]:

The water vapour pressure (p_s*) for saturated air temperature t^* is,

$$\log_{10} p_s^* = 16.386396 + 0.00137804\, t^* - 5656/(459.67 + t^*) - 3.560573 \times \log_e [(459.67 + t^*)/100] \qquad \ldots(3.1.1)$$

where temperature t^* is adapted in degrees Fahrenheit.

Specific Heat of Dry Air:

The specific heat of bone-dry air at temperature t^*, is

$$c_p^* = 0.2402 + [(0.0000014)(t^*-50)] \qquad \ldots(3.1.2)$$

The term in brackets is a slight adjustment for temperatures above 50°F in order to give a match with tabulation in ASHRAE, Hand book of Fundamentals[12], chapter 21, Table 1. It is to be taken as 0 at temperatures of 50°F and below.

Enthalpy of Saturated Water Vapour[12]:

Enthalpy of saturated water vapor at temperature t* is

$$hg^* = 0.444t^* + 1061 \quad \ldots \quad (3.1.3)$$

Values computed from this equation are found to agree with the data published in ASHRAE, Handbook of Fundamentals[12], Table 2.

Enthalpy of Condensed Water:

$$h_w^* = t^* - 32.00 + [0.11] \quad (3.1.4)$$

The adjustment in brackets is made to approximate closely the data in ASHRAE, Hand book of Fundamentals[12], Table 1.

The preceding relationships yield the following expressions for humidity ratio of moist air. Humidity ratio for saturated air at wet bulb temperature t* is,

$$W_s^* = (0.62197)\{p_s^*/(p-p_s^*)\} + [1.95(t^*+60)^5/10^{15}]$$

$$\ldots \quad (3.1.5)$$

The foregoing is from ASHRAE, Hand book of Fundamentals[12], with term in brackets added empirically to make small adjustment for strict agreement with tabulated values.

Humidity ratio for moist air at prevailing dry bulb and wet bulb temperatures is,

$$W = W_s^* - (t-t^*)\ [cp_a^*/(h_g^*-h_w^*)] \quad (3.1.6)$$

Alternatively the humidity ratio at dry bulb temperature t, relative humidity ϕ and saturated vapor pressure p_s', is

$$W' = \frac{0.622\ \phi\ p_s'}{p'-p_s'\ \phi}$$

Calculations of wet bulb temperature from the observed dry bulb temperature, relative humidity and barometric pressure are then carried out in the following manner.

(1) Saturated water vapor pressure at observed dry bulb temperature is calculated from equation (3.1.1),

$$p_s' = 10^R$$

where, $R = 16.386396 + 0.00137804\ t_{db} - 5656/(459.67 + t_{db})$

$$- 3.560573\ \log_e\ [(459.67 + t_{db})/100] \quad \ldots \quad (3.1.8)$$

(2) Actual humidity ratio for given data is given by equation (3.1.7),

$$W' = 0.622 \frac{\phi\ p_s'}{p' - \phi p_s'} \qquad (3.1.9)$$

where p' is the observed barometric pressure.

(3) As a first guess, the values of wet bulb temperature are assumed to be,

$$t_{wb} = t_{db} - 15 \qquad (3.1.10)$$

(4) Specific heat of dry air at this wet bulb temperature is given by equation (3.1.3),

$$c_p^* = 0.2402 + [(0.0000014)\ (t_{wb} - 50)] \quad \text{for } t_{wb} > 50^oF$$

$$c_p^* = 0.2402 \qquad \text{for } t_{wb} \leq 50^oF \qquad (3.1.11)$$

Enthalpy of saturated water vapor is given by equation (3.1.3),

$$h_g^* = 0.444\ t_{wb} + 1061 \qquad (3.1.12)$$

Humidity ratio for saturated air at this wet bulb temperature is given by equation (3.1.5),

$$W_s^* = (0.62197)\{p_s^*/(p-p_s^*)\} + [1.95(t_{wb}+60)^5/10^{15}] \qquad (3.1.14)$$

Humidity ratio at prevailing dry bulb temperature and assumed wet bulb temperature is given by equation (3.1.6),

$$W = W_s^* - (t_{db}-t_{wb})[cp_a^*/(h_g^*-h_w^*) \qquad (3.1.15)$$

(5) A function F is defined as,

$$F = W-W' \qquad (3.1.16)$$

If the assumed value of wet bulb temperature were the true ~~value~~, then,

$$F = 0$$

Combining equations (3.1.15) and (3.1.16),

$$F = W_s^* - (t_{db} - t_{wb})\ [cp_a^*/(h_g^*-h_w^*)] - W' \qquad (3.1.17)$$

Differentiating (3.1.17) with respect to t_{wb},

$$\frac{dF}{dt_{wb}} = \frac{dW_s^*}{dt_{wb}} + [cp_a^*/(h_g^* - h_w^*)] - (t_{db} - t_{wb}) \times [(h_g^*-h_w^*)\frac{dcp_a^*}{dt_{wb}} \times cp_a^* (\frac{dh_g^*}{dt_{wb}} - \frac{dh_w^*}{dt_{wb}})] / (h_g^* - h_w^*)^2 \qquad (3.1.18)$$

W_s^* from equations (3.1.14) and (3.1.1) may be written as,

$$W_s^* = 0.62197\ [10^{R1}/(p-10^{R1})] + [1.95(t_{wb}+60)^5/10^{15}] \quad \ldots \quad (3.1.19)$$

where $R1 = 16.386396 + 0.00137804\ t_{wb} - 5656/(459.67 + t_{wb}) - 3.560573 \log_e [(459.67 + t_{wb})/100]$.

Differentiating equation (3.1.19) with respect to t_{wb},

$$dW_s^*/dt_{wb} = 0.62197p \times 10^{R1} \log_e 10/(p-10^{R1})^2$$
$$[0.00137804 + 5656/(459.67 + t_{wb})^2 - 3.560513/(459.67 + t_{wb})] + 5. \times 1.95\ (t_{wb} + 60)^4/10^{15} \qquad (3.1.20)$$

Differentiating equations (3.1.11), (3.1.12) and (3.1.13),

$$dh_g^*/dt_{wb} = 0.444 \qquad (3.1.21)$$

$$dh_w^*/dt_{wb} = 1 \qquad (3.1.22)$$

$$\left.\begin{aligned} dcp^*/dt_{wb} &= 0 && \text{for } t_{wb} \leq 50 \\ dcp^*/dt_{wb} &= 0.0000014 && \text{for } t_{wb} > 50 \end{aligned}\right\} \qquad (3.1.23)$$

Substituting values from equation (3.1.20) to equation (3.1.23) into equation (3.1.18), dF/dt_{wb} may be calculated.

(6) Next approximation is made by Newton Raphson convergence techniquex as,

$$t_{wb}\ (I+1) = t_{wb}(I) - F/(dF/dt_{wb}) \qquad (3.1.24)$$

(7) Steps from equation (3.1.11) to equation (3.1.23) are repeated until the difference between two successive approximations of t_{wb} is less than 0.001°F and the difference between actual humidity ratio calculated by equation (3.1.9) and the humidity ratio xapproximated by equation (3.1.15) is less than 0.00001. The value of t_{wb} thus obtained is the required wet bulb temperature corresponding to the given dry bulb temperature, relative humidity and barometric pressure.

3.2 Computation of Outdoor Design Conditions:

Outdoor conditions contribute to the system load in the following two ways,

(i) Sensible heat gain through the structure.

(ii) Sensible and latent heat gain from infiltration and the required ventilation.

Expressions for sensible heat gain through the glazed and opague surfaces of the structure are presented in Sec. 3.3. It may be concluded from these expressions that sensible heat gain through structure is directly proportional to the daily maximum dry bulb temperature of the day and inversely to the daily dry bulb temperature range.

Heat gain and moisture gain in the space by exchange of air through infiltration or ventilation are given by,

$$q = m_a (h_o - h_i) \quad (3.2.1)$$

$$m_W = m_a (W_o - W_i) \quad (3.2.2)$$

where, q is the rate of heat transfer, Btu/hr

m_a is the rate of exchange of dry air lba/hr.

h_o and h_i are respectively the enthalpy of outdoor and indoor air, Btu/lba.

m_W is the rate of moisture transfer lbw/hr.

W_o and W_i are respectively the humidity ratio of the outdoor and indoor air, lbw/lba.

It may be concluded from these expressions that infiltration and ventilation load is directly proportional to the daily

maximum dry bulb and wet bulb temperatures and inversely proportional to the daily dry bulb and wet bulb temperature ranges.

Average Hourly Temperature Distribution:

The selection of design outdoor conditions from recorded weather data should, therefore, be governed both by daily maximum temperature values and the daily temperature range. The design day would be one where maximum daily temperature is high and most hourly temperature values cluster around the maximum value. Keeping this objective in mind, a new parameter "Average Hourly Temperature Deviation" denoted by σ is introduced. This is the averages for 24 hours, of the deviation of hourly temperature values from the maximum temperature for the day, that is,

$$\sigma = 1/23 \sum_{h=1}^{24} [T_{omax} - T_h] \qquad (3.2.3)$$

where, T_{omax} is the maximum outside temperature of the day,

T_h is the hourly outside temperature at the hour h,

Obviously, average hourly temperature deviation will always be a positive quantity.

Intutively it appears that the value of average hourly temperature deviation would seriously effect the peak loads and total load on the equipment. This can be demonstrated by studying its effect on heat transmission through structures.

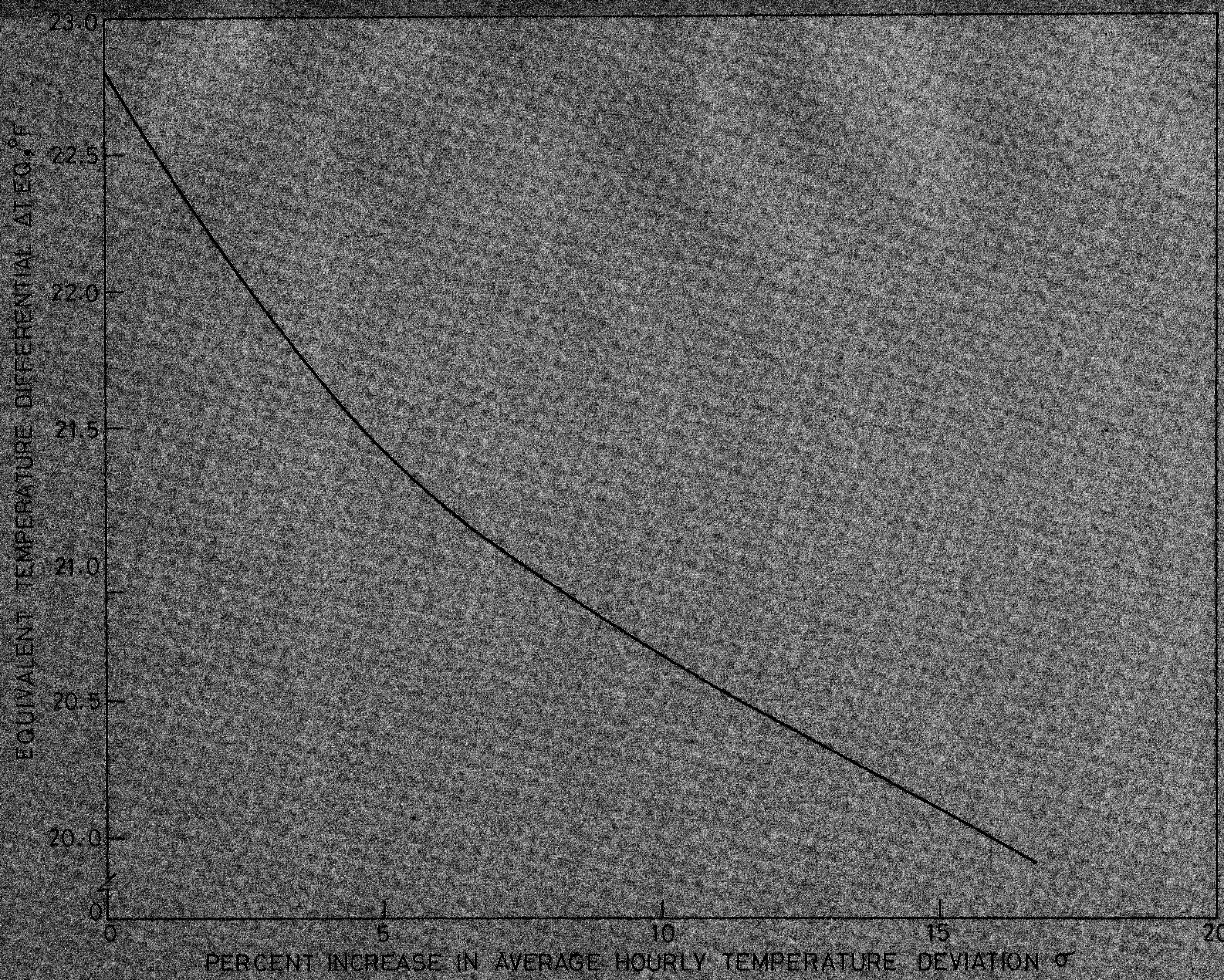

FIG.3.2.1 EFFECT OF AVG. HOURLY TEMPERATURE DEVIATION ON EQUIVALENT TEMPERATURE DIFFERENTIAL FOR SOUTH WALL CONSTRUCTION TYPE II IN BHOPAL ON 15TH. JUNE

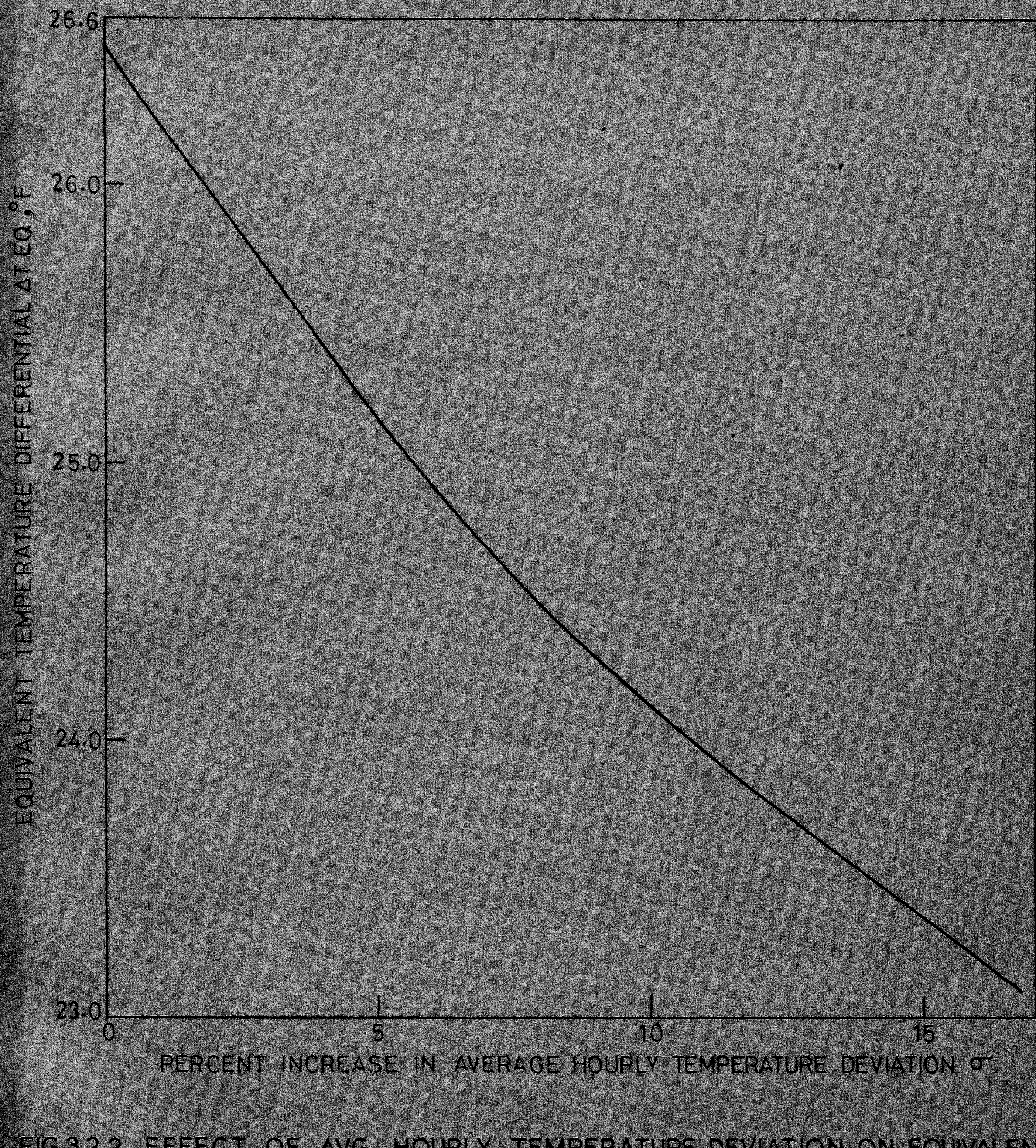

FIG 3.2.2 EFFECT OF AVG. HOURLY TEMPERATURE DEVIATION ON EQUIVALENT TEMPERATURE DIFFERENTIAL FOR SOUTH WALL CONSTRUCTION TYPE I IN BHOPAL ON 15TH JUNE

Figures 3.2.1 and 3.2.2 present the results for Bhopal computed from the observed data for years 1955 through 1964. These curves indicate that an increase in average hourly temperature deviation substantially reduces the peak loads and vice versa.

Optimality Criteria:

The following optimality criteria may be chosen for predicting design conditions,

(1) A high value of daily maximum dry and wet bulb temperatures which are not exceeded a specified number of times in the year.

(2) A low value of daily dry and wet bulb temperature ranges, such that values lower than these are not encountered a specified number of times a year.

Student's t Distribution:[14]

Student's t distribution has been applied to the reported weather data in order to predict the daily maximum dry and wet bulb temperatures, and daily dry and wet bulb temperature ranges.

Following assumptions have been made,

(i) Recorded data for the Ist and 15th of each month represent the average values for the fifteen days around each of these two dates.

(ii) Daily maximum temperatures for anyone, date, say July 1st, are randomly distributed over the years.

(iii) Daily ranges for a specific date are randomly distributed over the years.

For the present investigation, sample of 10 years data are used to predict the daily temperatures for various confidence limits.

In simple sampling from a population with mean μ and variance σ^2, the distribution of the mean $\bar{x}$ of the sample of n members has μ for its mean and σ^2/n for its variance. This result holds whether the sample is small or large and whether population is normal or not. Statistic S^2, defined by

$$S^2 = \frac{1}{n-1} \sum_{i=1}^{n} (x_i - \bar{x})^2$$

is an unbiased estimate of the population variance σ^2. This estimate of σ^2 is said to be based on (n-1) degrees of freedom, since $(x_i - x)$ are not independent, being connected by linear relation $\sum_{i=1}^{n} x_i - \bar{x} = 0$.

In simple sampling from a normal population of mean and variance σ^2, the deviation $\bar{x} - \mu$ is a normal variate. (A variable which possess a probability distribution is often called variate) with mean 0 and standard deviation $\sigma/\sqrt{n}$ where σ is the standard deviation of population. The quotient of $(\bar{x} - \mu)$ divided by $\sigma/\sqrt{n}$ is, therefore, normally distributed. If however, in place of the constant σ, we use the variable estimate s from the sample we have statistic,

$$t = (\bar{x} - \mu) \sqrt{n} / S$$

which is not normally distributed (The distribution discovered by W.S. Gosset).

In random sampling the probability that the value of t will fall in the interval 2t is given by,

$$dp = dt/\sqrt{\nu}B(1/2, 1/2\,\nu)(1+t^2/\nu)^{1/2(\nu+1)}$$

$$\text{where } B(m, n) = \int_0^1 (x^{m-1} + x^{n-1})/(1+x)^{m+n} \,.\, dx$$

The probability curves for various values of t have been presented in the literature[15].

<u>Chief Features of t-distributions:</u>

The equation to the t probability curve is,

$$y = 1/\sqrt{\nu}\ B(\frac{1}{2}, \frac{\nu}{2}) \,.\, 1/(1+ \frac{t^2}{\nu})^{1/2\ (\nu+1)}$$

The curve is symmetrical about the line $t = 0$ since only even powers of t appear in the equation of curve. Further since $1/1+(t^2/\nu)$ decreases rapidly as $|t|$ increases, the t-curve will tail off to zero on each side of the origin. In other words the curve is asymptotic to the t-axis at each end. The curve has maximum ordinate at $t = 0$.

The probability that the value of t from a random sample will be between two fixed values t_1 and t_2 is given by integrating y with respect to t from t_1 to t_2.

Similarly, if P be the probability that the value of $|t|$ from a random sample will exceed t_0 we have,

$$P = 2 \int_{t_o}^{\infty} 1/(\sqrt{\nu}B(\tfrac{1}{2}, \tfrac{\nu}{2})) \times dt/(1+(t^2/\nu))^{1/2\ (\nu+1)}$$

Values of t_o have been tabulated in the literature[16] for various fixed values of P for various values of ν. These are to be used for smaller samples where $\nu \leq 60$. For values of $\nu > 60$, the fact t is asymptotic permits the use of a standard normal variate.

Example:

The maximum daily temperature for Delhi on 15th June for 10 years (1955-64) are shown in the following table. Objective is to predict, for various confidence limits, the daily maximum temperatures for Delhi on 15th June.

Table 3.2.1: MAXIMUM DAILY TEMPERATURE, JUNE 15TH DELHI

Year	Daily Maximum	
	Temp. ^oF	$(Temp-\bar{x})^2$
1955	104.00	6.25
1956	103.30	3.42
1957	106.60	26.52
1958	109.76	68.89
1959	104.00	6.25
1960	88.00	12.25
1961	106.00	20.25
1962	103.10	3.14
1963	87.80	12.00
1964	102.00	0.25

$\nu = 10$

$\bar{x}$ = 101.456 σ of population = 1.4

from tables[16] values of t for 75%, 90%, 95%, 97.5% and 99.5% confidence limits are found to be,

$t_{.50} = 0.70$ $t_{.90} = 1.81$ $t_{.95} = 2.23$

$t_{.98} = 2.76$ $t_{.99} = 3.17$

$$T_{max.50} = \bar{x} + t_{.50} \times \sigma$$
$$= 101.456 + 0.70 \times 1.4$$
$$= 102.43^{o}F$$

$$T_{max.90} = 101.45 + 1.81 \times 1.4$$
$$= 104^{o}F$$

$$T_{max.95} = 101.45 + 2.23 \times 1.4$$
$$= 104.57$$

$$T_{max.98} = 101.45 + 2.76 \times 1.4$$
$$= 105.31$$

$$T_{max.99} = 101.45 + 3.17 \times 1.4$$
$$= 105.88$$

3.3 Computation of Hourly Temperature Distribution for India:

A mathematical model has been developed to find out the average (for all cities of India) hourly temperature distribution for various values of daily temperature range and different values of the average hourly temperature deviation.

Definitions and Formulation:

Daily temperature range is defined as,

$$\text{Daily range} = T_{max} - T_{min} \qquad (3.3.1)$$

where T_{max} is the maximum temperature of the day.

T_{min} is the minimum temperature of the day.

Hourly temperature differential at any hour t is defined as,

$$D_t = T_t - T_{min} \qquad (3.3.2)$$

where, T_t is the temperature at any hour t.

t is the time in hours reckoned from midnight.

The entire collected data for 28 stations is sorted out by various specific values of daily temperature range. For each value of the range, a sinusoidal curve for hourly temperature differential is assumed and the error between the assumed curve and the actual temperature differential is minimised.

In the present analysis, hourly temperature differential has been assumed to be periodic with 12 harmonics,

$$D_t = a_o + \sum_{N=1}^{11} a_N \sin N\omega t + \sum_{N=1}^{12} b_N \cos N\,\omega t \qquad (3.3.3)$$

where $\omega = \pi/12$

SINE term of 12th harmonic is redundant, since this is always zero for Integral hours.

Most likely times of occurrence of maximum temperature of the day and minimum temperature of the day are established by frequency of their occurrence at various times. Let these times be H_{max} and H_{min} respectively.

Constraints:

Then the following constraints follow from equations (3.3.1) through (3.3.3),

$$a_o + \sum_{N=1}^{11} a_N \sin N\omega H_{max} + \sum_{N=1}^{12} b_N \cos N\omega H_{max} = \text{Range} \tag{3.3.4}$$

and

$$a_o + \sum_{N=1}^{11} a_N \sin N\omega H_{min} + \sum_{N=1}^{12} b_N \cos N\omega H_{min} = 0 \tag{3.3.5}$$

Mean value of the average hourly temperature deviation is found from the data having the specified range. It is termed σ_{av}. Thereby following additional constraint can be formulated using equations (3.3.1) and (3.3.3),

$$\frac{1}{23} \sum_{t=1}^{24} [\text{Range} - (a_o + \sum_{N=1}^{11} a_N \sin N\omega t + \sum_{N=1}^{12} b_N \cos N\omega t)]$$
$$= \sigma_{av}. \tag{3.3.6}$$

Error Function:

Total error is defined as the sum of the squares of error between the assumed curve and actual temperature differential at selected points,

$$\text{Total error} = \sum_{1}^{\text{No. of days}} \sum_{t=1}^{24} [\{a_o + \sum_{N=1}^{11} a_N \sin N\omega t$$
$$+ \sum_{N=1}^{12} b_N \cos N\omega t\} - T_t]^2 \tag{3.3.7}$$

where, T_t is the actual temperature differential at time t.

The equality constraints given by equations (3.3.4), (3.3.5) and (3.3.6) are introduced in the above error function through Lagrangian multipliers λ_1, λ_2 and λ_3 as follows,

$$E = \sum_{1}^{\text{No. of days}} \sum_{Nt=1}^{24} \Big[\Big(a_o + \sum_{N=1}^{11} a_N \sin N\omega t + \sum_{N=1}^{12} b_N \cos N\omega t\Big) - T_t\Big]^2$$
$$+ \lambda_1 \Big[\text{Range} - \Big(a_o + \sum_{N=1}^{11} a_N \sin N\omega H_{max} + \sum_{N=1}^{12} b_N \cos N\omega H_{max}\Big)\Big]$$
$$+ \lambda_2 \Big[a_o + \sum_{N=1}^{11} a_N \sin N\omega H_{min} + \sum_{N=1}^{12} b_N \cos N\omega H_{min}\Big]$$
$$+ \lambda_3 \Big[\sigma_{av} - (1/23) \sum_{t=1}^{24} \Big\{\text{Range} - \Big(a_o + \sum_{N=1}^{11} a_N \sin \omega N\, t$$
$$+ \sum_{N=1}^{12} b_N \cos N\omega t\Big)\Big] \qquad (3.3.8)$$

<u>Minimizing the Error:</u>

The error function E in equation (3.3.8) is now minimised with respect to the coefficients a_o, a_1, ... a_{11}, b_1, ... b_{12}; and multipliers λ_1, λ_2, λ_3. This is accomplished by differentiating the error function E with respect to each one of these coefficients and multipliers and equating each one of the derivative to zero.

$$\partial E/\partial a_o = \Big[\sum_{1}^{\text{No. of days}} \sum_{t=1}^{24} 2 \times \Big\{\Big(a_o + \sum_{N=1}^{11} \sin N\omega t$$
$$+ \sum_{N=1}^{12} b_N \cos N\omega t\Big) - T_t\Big] - \lambda_1 + \lambda_2 + (\lambda_3/23) \sum_{t=1}^{24} 1 \qquad (3.3.9)$$

$$\partial E/\partial a_N = \sum_{1}^{\text{NO. of days}} \sum_{t=1}^{24} 2 \times \Big[\Big(a_o + \sum_{N=1}^{11} a_N \sin N\omega t$$
$$+ \sum_{N=1}^{12} b_N \cos N\omega t\Big) - T_t\Big] \sin N\omega t_t$$
$$- \lambda_1 \sin N\omega H_{max} + \lambda_2 \sin N\omega H_{min} + \lambda_3 \times \frac{1}{23} \sum_{i=1}^{24} \sin N\omega t$$

where $N = 1, \ldots 11$ (3.3.10)

$$\partial E/\partial b_N = \sum_{1}^{\text{No. of days}} \sum_{t=1}^{24} 2 \times [(a_o + \sum_{N=1}^{11} a_N \sin N\omega t + \sum_{N=1}^{12} b_N \cos N\omega t) - T_t] \cos N\omega t$$

$$- \lambda_1 \cos N\omega H_{max} + \lambda_2 \cos N\omega H_{min} + \lambda_3 \times \frac{1}{23} \sum_{t=1}^{24} \cos N\omega t$$

where N = 1, ... 11 (3.3.11)

$$\partial E/\partial \lambda_1 = \text{Range} - (a_o + \sum_{N=1}^{11} a_N \sin N\omega H_{max} + \sum_{N=1}^{12} b_N \cos N\omega H_{max}) \quad (3.3.12)$$

$$\partial E/\partial \lambda_2 = a_o + \sum_{N=1}^{11} a_N \sin N\ H_{min} + \sum_{N=1}^{12} b_N \cos N\omega H_{min} \quad (3.3.13)$$

$$\partial E/\partial \lambda_3 = \sigma_{av} - (1/23) \sum_{t=1}^{24} [\text{Range} - (a_o + \sum_{N=1}^{11} a_N \sin N\omega t + \sum_{N=1}^{12} b_N \cos N\omega t)] \quad (3.3.14)$$

Now putting,

$\partial E/\partial a_o = 0$

$\partial E/\partial a_N = 0$ for N = 1, ...11

$\partial E/\partial b_N = 0$ for N = 1, ...12

$\partial E/\partial \lambda_1 = 0$

$\partial E/\partial \lambda_2 = 0$

$\partial E/\partial \lambda_3 = 0$

and rearranging to obtain 27 simultaneous linear equations containing 27 unknowns a_o, a_1 ... a_{11}, b_1, ... b_{12}, λ_1, λ_2, λ_3 as follows,

Ist Equation

$$\sum_{1}^{\text{No. of days}} \sum_{t=1}^{24} 2x(a_o + \sum_{N=1}^{11} a_N \sin N\omega t + \sum_{N=1}^{12} b_N \cos N\omega t)$$

$$-\lambda_1 + \lambda_2 + (24/23)\ \lambda_3 = 2 \sum_{1}^{\text{No. of days}} \sum_{t=1}^{24} T_t \quad (3.3.15)$$

$$\sum_{1}^{\text{No. of days}} \sum_{t=1}^{24} 2 \sin N\omega t \left(a_o + \sum_{N=1}^{11} a_N \sin N\omega t + \sum_{N=1}^{12} b_N \cos N\omega t\right)$$

$$-\lambda_1 \sin N\omega H_{max} + \lambda_2 \sin N\omega H_{min} + (\lambda_3/23) \sum_{t=1}^{24} \sin N\omega t$$

(N+1) th equation

$$= \sum_{t=1}^{24} 2 \sin N\omega t \sum_{1}^{\text{No. of days}} T_t$$

where $N = 1, \ldots 11$

$$\sum_{1}^{\text{No. of days}} \sum_{t=1}^{24} 2 \cos N\omega t \left(a_o + \sum_{N=1}^{11} a_N \sin N\omega t + \sum_{N=1}^{12} b_N \cos N\omega t\right)$$

$$- \lambda_1 \cos N\omega H_{max} + \lambda_2 \cos N\omega H_{min} + (\lambda_3/23) \sum_{t=1}^{24} \cos N\tilde{\omega} t$$

$$= 2 \sum_{t=1}^{24} \cos N\omega t \sum_{1}^{\text{No. of days}} T_t$$

(2N+1) th equation where $N = 1, \ldots 12$

$$a_o + \sum_{N=1}^{11} a_N \sin N\omega H_{max} + \sum_{N=1}^{12} b_N \cos N\omega H_{max} = \text{Range}$$

$$a_o + \sum_{N=1}^{11} a_N \sin N\omega H_{min} + \sum_{N=1}^{12} b_N \cos N\omega H_{min} = 0$$

$$(1/23) \left[\sum_{t=1}^{24} \left(a_o + \sum_{N=1}^{11} a_N \sin N\omega t + \sum_{N=1}^{12} b_N \cos N\omega t\right)\right]$$

$$= \sigma_{av} - (24/23) \text{ Range}$$

<u>Solution:</u>

These equations have been solved for $a_o, \ldots a_{11}$, $b_1, \ldots b_{12}, \lambda_1, \lambda_2, \lambda_3$ by Gauss Jordan Method. The coefficient matrix is found to be diagonally dominant and no unusual difficulty is encountered in solving these equations. The values of coefficients $a_o, a_1 \ldots a_{11}, b_1, \ldots b_{12}$ thus obtained are substituted back into equation (3.3.3) and hourly temperature distribution is found.

3.4 Computation of Solar Heat Gain Through Glass*

Heat gain through glass due to solar radiation incident on the outer surface and due to temperature difference between outdoors and indoors constitutes upto 25 percent of the total equipment load for air conditioning of many modern buildings. A complete procedure for estimating this component of the load is presented in this section. The various definitions and expressions presented here have been adapted from Thermal Environmental Engineering by Professor Threlkeld,[2] American Society of Heating and Refrigerating and Air Conditioning Engineers Guide 1967 - Handbook of Fundamentals[12], and the various research papers published in the literature. The objective has been to bring together most of the published information as applicable to load calculations in India; these expressions have also been incorporated in the computer program for system load calculations presented in Chapter 4.

Basic Solar Angles

The latitude l is the angular distance of the point P north (or south) of the equator. It is the angle between the radius vector $\overline{OP}$ (Figure 3.4.1) and the projection of $\overline{OP}$ on the equatorial plane. Point O represents the center of the earth.

The hour angle h is the angle through which the earth must turn to bring the meridian of point P directly line with sun's rays. At noon (solar time) the hour angle is zero. The hour angle expresses the time of the day with respect to solar noon.

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* Some of the material and figures have been reproduced from chapters 14 and 15 of the book, "Thermal Environmental Engineering" by Professor Therelkeld, which is greatly acknowledged.

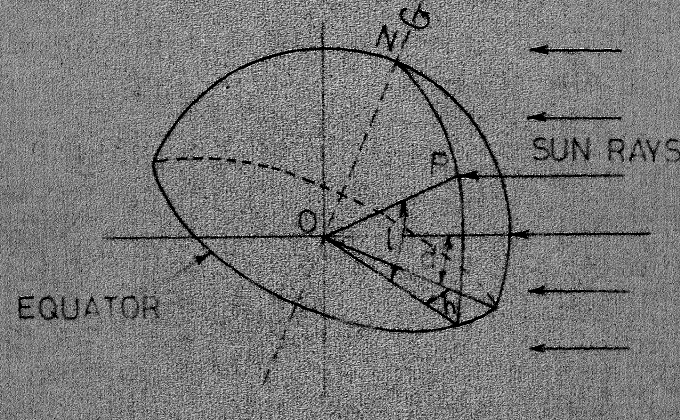


FIG .3.4.1 LATITUDE HOUR ANGLE AND SUN'S DECLINATION

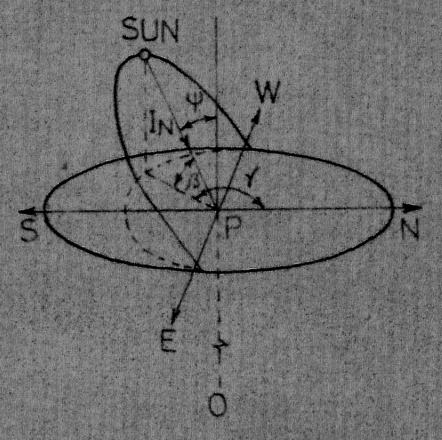


FIG.3.4.2 DEFINITION OF SUN'S ZENITH ALTITUDE AND AZIMUTH ANGLES

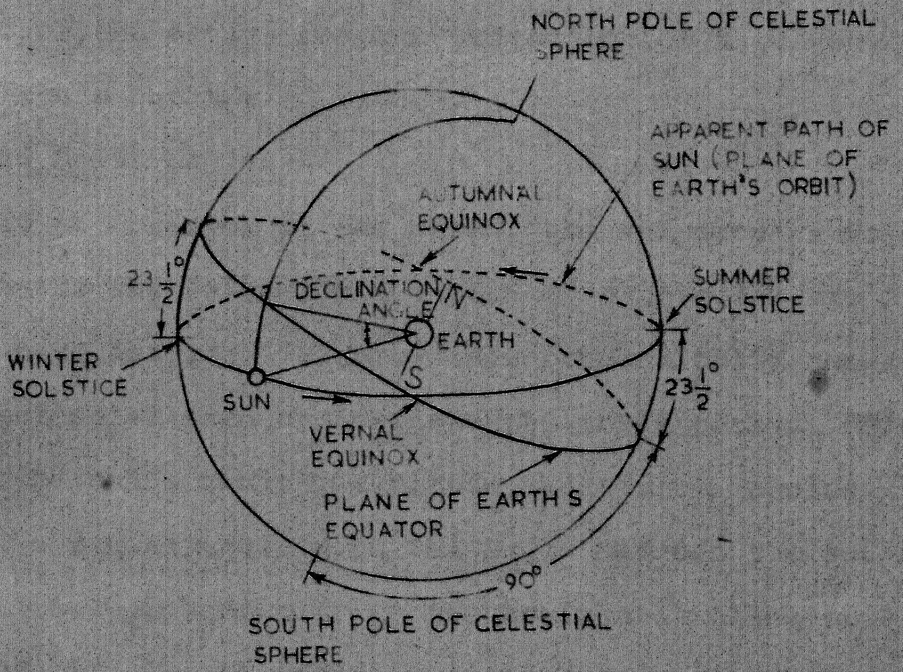


FIG.3.4.3 SCHEMATIC CELESTIAL SPHERE SHOWING APPARENT PATH OF SUN AND SUN'S DECLINATION ANGLE

One hour of time equals 360/24 or 15 degrees of hour angle.

The sun's declination d is the angular distance of the sun's rays north (or south) of the equator. As shown in Figure 3.4.3 the sun's declination is the angle formed at solar noon between a vector parallel to the sun's rays which would intersect the center of the earth, and the projection of this vector upon the earth's equatorial plane.

Derived Solar Angles

To an observer on the earth, the sun appears to move across the sky following the path of a circular arc from horizen to horizen. Figure 3.4.2 schematically shows the apparent solar path and defines the three derived solar angles, viz., the sun's zenith, altitude and azimuth angles.

The Zenith angle ψ is the angle between the sun's rays and a line perpendicular to the horizental plane at P (extension of $\overline{OP}$). Zenith angle is related to basic solar angles by

$$\cos \psi = \cos l \cos h \cos d + \sin l \sin d. \quad (3.4.1)$$

The altitude angle β is the angle in a vertical plane between the sun's rays and projection of the sun's rays on the horizental plane. It follows that

$$\beta + \psi = \pi/2 \quad (3.4.2)$$

Also the altitude angle may be expressed as

$$\sin \beta = \cos l \cos h \cos d + \sin l \sin d. \quad ..(3.4.3)$$

The azimuth angle γ is the angle in the horizental plane measured from north to the horizental projection of sun's rays. Sun's azimuth angle γ is given by the relation

$$\cos \gamma = \sec \beta(\cos 1 \sin d - \cos d \sin 1 \cos h)$$

Solar Angles for Tilted Surfaces

The angle of incidence θ is the angle between the sun's rays and the normal to the tilted surface.

The wall-solar azimuth angle α is the angle measured in a horizontal plane between the normal to the vertical surface and the horizontal projection of sun's rays.

For a tilted surface at an angle ϕ from the vertical it can be shown that

$$\cos \theta = \cos \beta \cos \alpha \cos \phi + \sin\beta\beta \sin \phi \quad (3.4.5)$$

If the surface is vertical $\phi=0$.

$$\cos \theta = \cos \beta \cos \alpha \quad (3.4.6)$$

If the surface is horizontal $\phi = \pi/2$

$$\cos \theta = \sin \beta = \cos \phi \quad (3.4.7)$$

At sun rise or sunset $\beta = 0$.

Hour angle at the sunrise or sunset is given by

$$\cos H = - \tan 1.\tan d. \quad (3.4.8)$$

Solar Constant

When the earth is at its mean distance from the sun, the solar radiation incident upon a surface normal to the sun's rays and at the outer limit of atmosphere is known as the

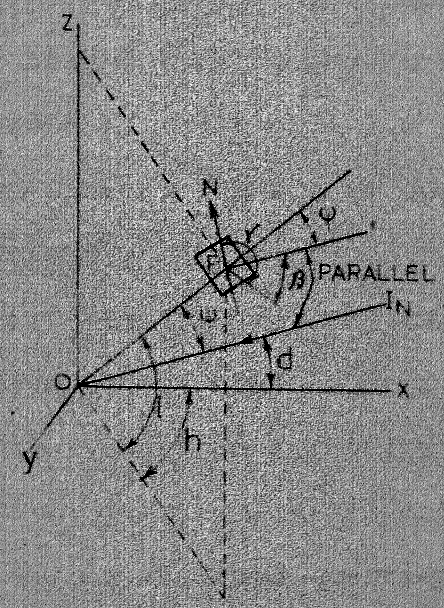


FIG.3.4.4 RELATION OF A POINT ON THE EARTH'S SURFACE TO SUN'S RAYS

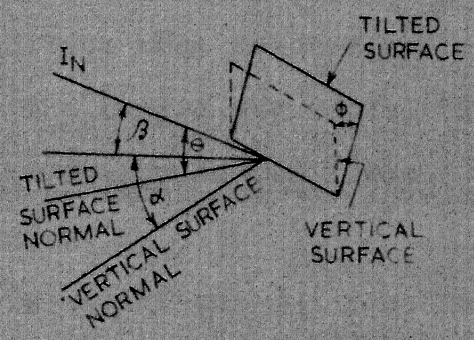


FIG.3.4.5 RELATION OF SUN'S RAYS TO A TILLED SURFACE

"Solar Constant". Expressed in the International scale of 1956, the solar constant has been determined by Johnson[15] to be 444.7 btu/hrft^2 with a probable error of $\pm$ 2.0 percent.

The effects of the earth's atmosphere upon solar radiation have been studied by scientist for many years. This research has shown that when solar radiation passes through the atmosphere part of it may be intercepted by constituents such as dry air molecules, water molecules and dust particles resulting in a scattering of radiation in practically all directions. Secondly part of the radiation may be absorbed, particularly by ozene in the upper atmosphere and by water vapour nearer the earth's surface. The remaining portion of the original direct radiation may reach the earth's surface unchanged.

Solar Radiation Incident on Earth's Surface

Some of the radiation intercepted by the atmosphere and turned aside from the direct beam reaches the earth's surface as diffuse radiation from the entire sky vault. Thus a surface on the earth receives solar energy of two forms -- direct radiation and diffuse radiation.

The total shortwave radiation. I_t reaching a terrestrial surface is the sum of the direct solar radiation, ID, the diffuse solar radiation, Id, and the solar radiation reflected from surrounding surfaces, Ir. The intensity of direct component is the product of the direct normal irradiation, IDN, and the cosine of the angle of incidence, θ, between the incoming

TABLE 3.4.1: VALUES OF A, B, C FOR CALCULATION OF SOLAR RADIATION INTENSITY.

Date	Equation of Time, min.sec.	Declination, degrees	A, Btu	B, Air Mass^{-1}	C(Dimension less
Jan. 21	-11:18	- 20	390	0.142	0.058
Feb. 21	-13:28	- 10.8	385	0.144	0.060
Mar. 21	- 7:19	0	376	0.156	0.071
Apr. 21	+ 0:08	+ 11.6	360	0.180	0.097
May 21	+ 3:32	+ 20.0	350	0.196	0.121
June 21	- 1:48	+23.45	345	0.205	0.134
July 21	- 6:25	+20.6	344	0.207	0.136
Aug. 21	- 1:18	+12.3	351	0.201	0.122
Sept.21	+ 7:30	0	365	0.177	0.092
Oct. 21	+15:06	-10.5	378	0.160	0.073
Nov. 21	$\pm$13:55	-19.8	387	0.149	0.063
Dec. 21	+ 1:32	-23.45	391	0.142	0.057

solar rays and a line normal to the surface.

$$It = IDN \cos \theta + Id + Ir$$

The value of IDN at the surface of the earth on a clear day is well represented by

$$IDN = A/\exp (B/\sin \beta) \qquad (3.4.10)$$

where A = apparent solar irradiation at air mass = 0

B = atmospheric extinction coeff.

The values of A and B vary during the year because of seasonal changes in the dust and water vapour. Content of the atmosphere and also because of changing earth sun distance. Values of A,B and C are listed in table (3.4.1)[12].

These data do not give the maximum value of IDN that can occur in each month but are representative of the conditions on average cloudless days.

The diffuse solar radiation from a clear sky that falls on any surface is given by

$$Ids = CIDN\ Fss$$

where, C is given in table (3.4.1)

Fss is the angle factor between surface and sky.

<u>Solar-Radiation Properties of Diathermanous Materials</u>

A diathermanous material is capable of transmitting thermal radiation. The most important example of these materials in building construction is glass.

The following discussions of solar radiation incident upon glass is based upon the treatise by Parmalee[16]

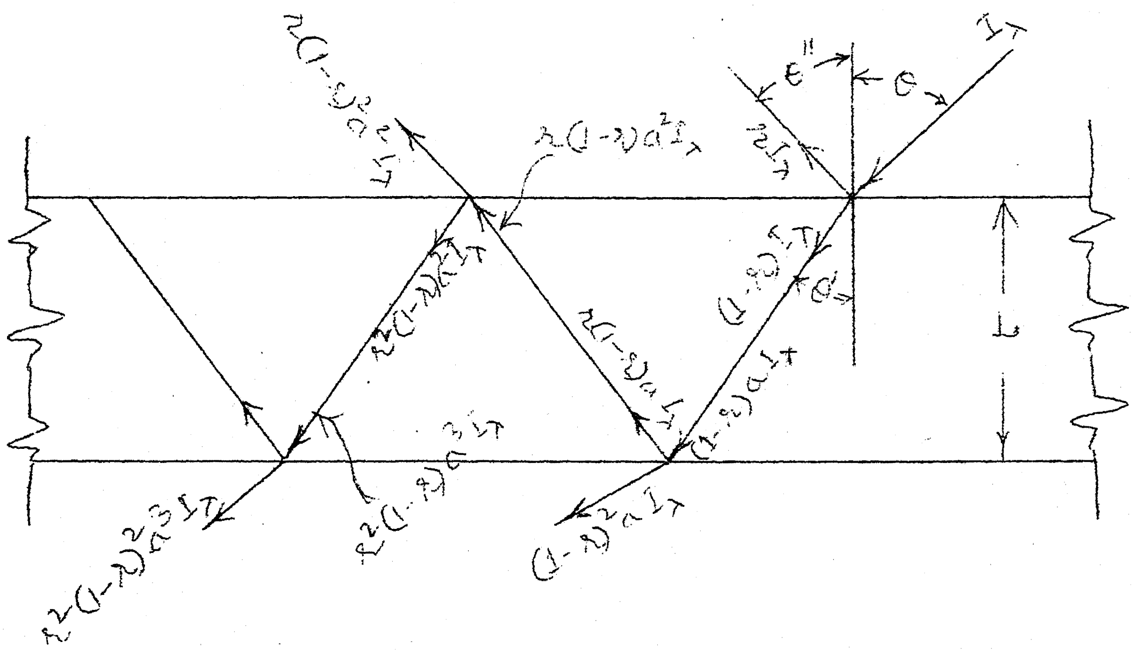


Figure (3.4.6) shows the disposal of a quantity of monochromatic direct solar radiation Iλ incident upon a single glass plate. Because of successive internal reflections, the reflected, absorbed and transmitted radiation quantities are given by infinite series. Let r be fraction reflected after each incidence, and a the fraction available after absorption during each path. The total monochromatic transmissivity is given by

$$\tau\lambda = (1-r)^2\ a + r^2(1-r^2)a^3 + r^4(1-r^2)a^5 + \ldots \quad (3.4.11)$$

Since this is a convergent series

$$\tau\lambda = (1-r)^2 a/(1-r^2-a^2) \quad (3.4.12)$$

Similarly total monochromatic reflectivity ρ_λ is given by

$$\rho_\lambda = r + r(1-r)^2 a^2/(1-r^2 a^2) \quad (3.4.13)$$

Also since

$$\alpha_\lambda = 1 - \tau_\lambda - \rho_\lambda \qquad (3.4.14)$$

the total monochromatic absorptivity is given by the relation

$$\alpha_\lambda = 1-r-(1-r)^2 a/(1-ra) \qquad (3.4.15)$$

For evaluation of these properties, r and a must be known. Parameter a is given by the relation[2]

$$a = e^{-KL'} \qquad (3.4.16)$$

where, K is called extinction coefficient

$$L' = L/\sqrt{1-\frac{\sin^2\theta}{n}} \qquad (3.4.17)$$

where, L is glass thickness

θ is the angle of incidence of sun's rays

n is the index of refraction for glass.

Parameter r may be found from the Fresnel relations

$$r = 1/2 \left[\frac{\sin^2(\theta-\theta')}{\sin^2(\theta+\theta')} + \frac{\tan^2(\theta-\theta')}{\tan^2(\theta+\theta')} \right] \qquad (3.4.18)$$

Parmalee[16] has also given similar expressions for double glass.

Finally, the rate of heat transfer through glass to the interior of the structure in Btu/hr ft^2, is given by,

$$q_i = F_s\tau_D I_D + \tau_d I_d + \tau_R I_R + \frac{(F_s \alpha_D I_D + \alpha_d I_d + \tau_P I_R)}{(1+h_o/h_i)} + (t_o-t_i)/(1/h_i+1/h_o)$$

where

F_s is sunlit fraction

τ is Transmissivity of glass

α is absorptivity of glass

I is solar radiation Intensity

h_o is outside heat transfer coefficient.

h_i is inside heat transfer coefficient.

t_o is outside ambient temperature

t_i is inside temperature of environment.

Subscript D refers to direct radiations

Subscript d refers to diffuse radiation

Subscript R refers to reflected radiant.

3.5 Computation of Heat Gain Through Walls and Roof *

Heat transmission occurs through solid boundaries of a structure if a temperature gradient exists between internal and external parts. Solar radiation also significantly affects the energy transmissions through boundaries.

Because of the fluctuations in temperature and incident solar radiation, the external thermal environment is constantly changing. Thus steady state transmission seldom occurs in building structure.

Two principal factors of the external thermal environments are:

(i) outdoor air temperature

(ii) solar radiation intensity

Both are subject to erractic fluctuations.

***Some of the material and figures have been reproduced from Chapters 14 and 15 of the book, "Thermal Environmental Engineering" by Prof. Therelkeld, which is greatly acknowledged.**

Assumptions: For further analysis following assumptions seem plausible

(i) Solar radiation intensity follows a periodic variation

(ii) Outdoor - air temperature is also periodic

(iii) Internal environment in the building is constant.

(iv) Peak loads occur on clear days.

The rate of heat transfer from the external thermal environment to the outside surface of a sunlit wall or roof may be written as

$$q_o = ho\ (to - tw,o) + \alpha I \qquad (3.5.1)$$

where

ho is external heat transfer coefficient

to is the dry bulb temperature of outside air

tw,o is the temperature of outside surface

α is the absorptivity of the outside surface

I is the combined incidence of solar radiation (direct, diffuse and reflected) upon the surface

For ordinary opague surface α varies only slightly with angle of incidence so that we may combine all radiation components into one quantity I.

For heat transmission calculations, it is convenient to combine the effects of outdoor-air temperature and solar radiation intensity into a single quantity. The rate of

heat transfer q_o may then be expressed as

$$q_c = h_o \ (t_e - t_{w,o}) \tag{3.5.2}$$

where

$$t_e = t_o + \alpha I/h_o \tag{3.5.3}$$

t_e is called sol-air temperature. Sol-air temperature is a fictitious temperature and it may be understood to mean the temperature of outdoor air, which in contact with a shaded building surface, would give the same rate of heat transfer and the same temperature distribution through material as exists with the actual dry bulb temperature of the outdoor air and the actual solar radiation intensity incident upon the surface. It was first introduced by Mackey and Wright(3).

Since outdoor-air temperature and solar radiation intensity have been assumed to be periodic-sol-air temperature is also essentially periodic. Sol-air temperature can therefore be expressed as a function of time t by Fourier series as follows:

$$T_e = T_{e,m} + T_{em1} \cos w_1 t + T_{e,n1} \sin w_1 t$$
$$+ T_{e,m2} \cos w_2 t + T_{e,n2} \sin w_2 t + \ldots \tag{3.5.4}$$

where, the coefficients $T_{e,m}$, T_{e,m_n} and T_{e,n_n} are given by

$$T_{e,m} = 1/24 \int_0^{24} T_e, \ dt \tag{3.5.5}$$

$$T_{e,m_n} = (1/12) \int_0^{24} Te \cos wnt \ dt \tag{3.5.6}$$

$$T_{e,n_n} = (1/12) \int_0^{24} Te \sin wnt \ dt \tag{3.5.7}$$

$$w_1 = \pi/12 \text{ radians/hour}$$

$$w_n = nw_1$$

Alternatively

$$Te = Te,m + \sqrt{Te^2,m_1 + Te^2,n_1} \cos (w_1-\psi_1)$$
$$+ \sqrt{Te^2,m_2+Te^2,n_2} \cos (w_2t-\psi_2) \qquad (3.5.8)$$

where $\tan \psi_n = Te, n_n/Te,m_n$ (3.5.9)

The Quadrant in which ψ_n lies is determined by the requirement that sin ψ_n must have the sign as Te, n_n, and that cos ${}_n$ must have the same sign as Te, m_n. This procedure was first given by Alfred, Ryan, Urban[18].

Periodic Heat Transfer Through Surfaces:

The expressions for periodic heat transfer through a wall formed by a single homogeneous material (or composite wall replaced by equivalent single homogeneous wall) have been presented by Mackey and Wright[3]. Figure 3.5 shows the schematic problem.

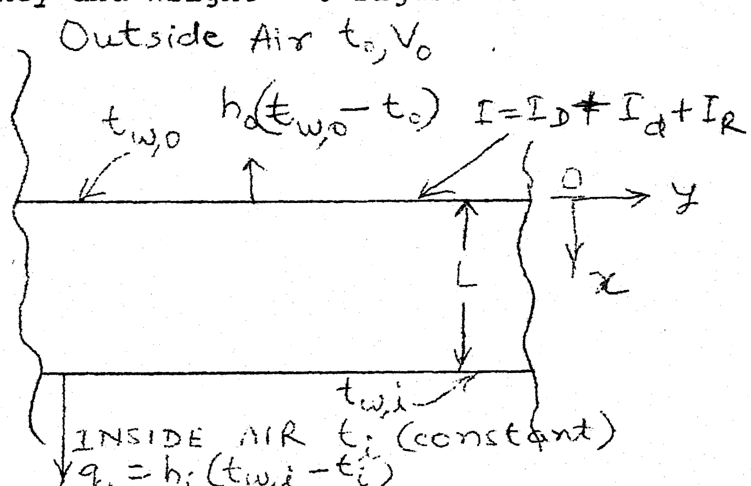


Figure 3.5.1

Following assumptions have been made:

(i) The wall is of infinite in length and height and heat transfer occurs only in the x direction.

(ii) Wall is homogeneous with constant material properties

(iii) The surface coefficients h_i and h_o are constants.

(iv) The solar absorptivity of the outside surface is independent of the angle of incidence and is constant.

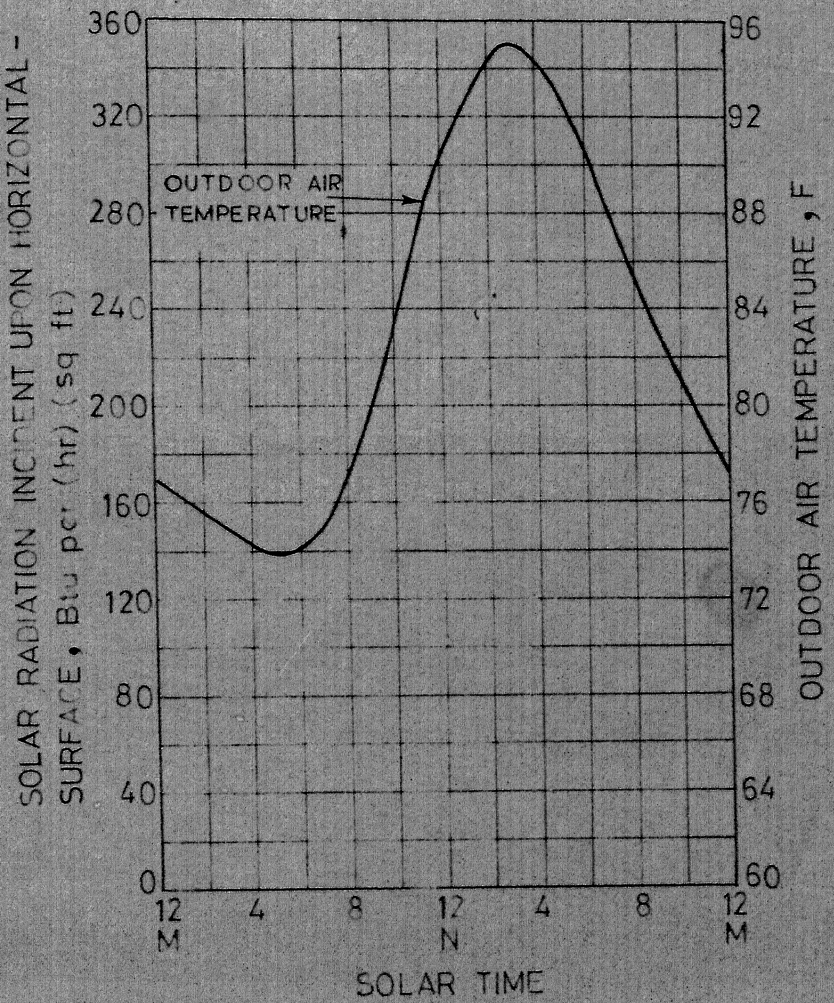


FIG.3.5.2 A TYPICAL VARIATION OF OUTDOOR AIR TEMPERATURE

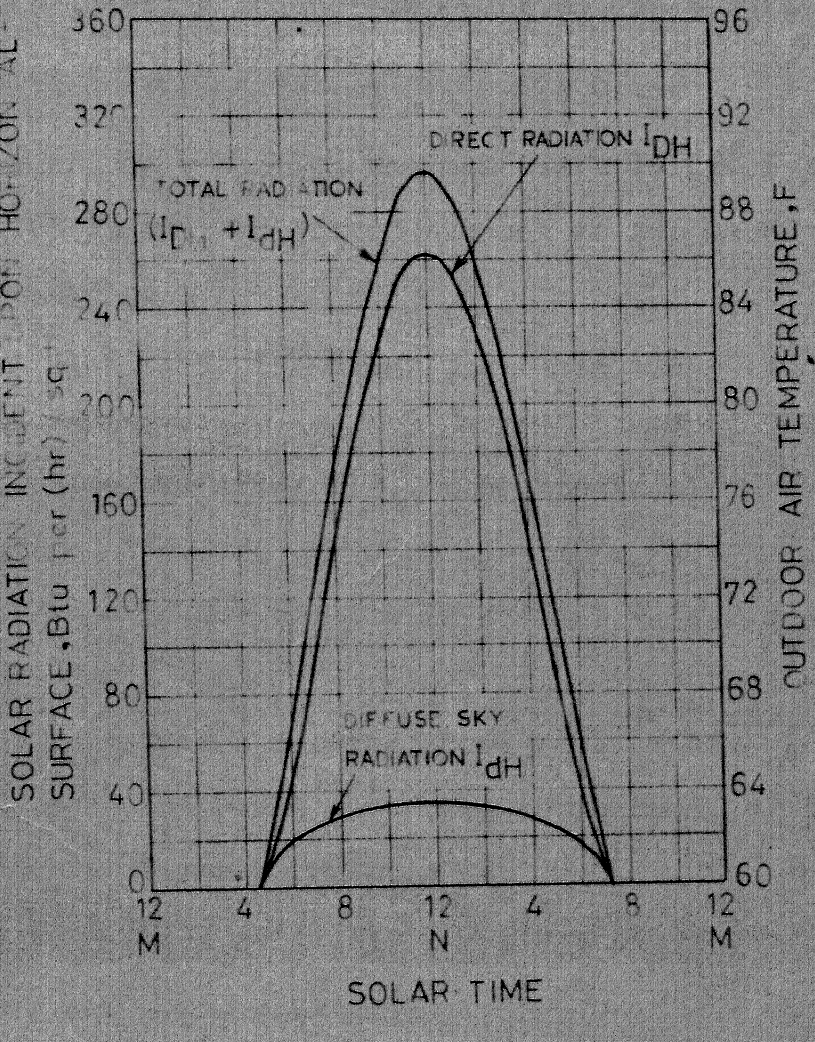


FIG. 3.5.3 A TYPICAL VARIATION OF SOLAR RADIATION INTENSITY INCIDENT UPON A SURFACE

(v) The variation of To and I are periodic (identical with time on consecutive days), and

(vi) The internal environment is constant

At any location conduction equation may be written as

$$\frac{\partial tw}{\partial t} = \alpha w \frac{\partial^2 tw}{\partial x^2} \qquad (\ o) \qquad (3.5.10)$$

where $\alpha w = k_w/\rho_w c_w$ thermal diffusivity of the wall.

Equation 3.5.10 must be solved subject to two boundary conditions

At inside surface

$$q_i = -kw(\partial tw/\partial \mathbf{x})_{x=L} = hi(tw,i-ti)$$

at outside surface (3.5.11)

$$q_o = -kw\ (\partial tw/\partial x)_{x=o} = ho\ (te-tw,o) \qquad (3.5.12)$$

where

$$te = te,m + te_1 \cos\ (w_1 t - \psi_1) + te,2 \cos(w_2 t-\psi_2) \qquad (3.5.13)$$

Complete solution for the above problem has been given by Alford, Ryan and Urban(18). The temperature of the inside wall surface tw,i may be written as

$$tw,i = ti + \frac{1}{hi}\ [U(t_{e,m}-t_i)\ V_1 t_{e1} \cos(w_1 t-\psi_1-\phi_1)$$

$$+ V_2 t_{e2} \cos\ (w_2 t - \psi_2-\phi_2) \qquad (3.5.14)$$

where

$$U = \frac{1}{(1/hi + 1/kw + 1/h_o)} \qquad (3.5.15)$$

$$V_n = \frac{h_o h_i}{(\sigma_n kw\sqrt{Yn^2+Zn^2})} \qquad (3.5.16)$$

$$\sigma_n = \sqrt{w_n}/2\alpha w \qquad (3.5.17)$$

$$Y_n = \left(\frac{h_o h_i}{2\sigma_n^2 k w^2} + 1\right) \cos \sigma_n L \sinh \sigma_n L$$
$$+ \left(\frac{h_o\ h_i}{2\sigma_n^2 k w^2} - 1\right) \sin \sigma_n L \cosh \sigma_n L$$
$$+ \left(\frac{h_o h_i}{\sigma_n k w}\right) \cos \sigma_n L \cosh \sigma_n L \qquad (3.5.18)$$

$$Z_n = \left(\frac{h_o h_i}{2\sigma_n^2 k w^2} + 1\right) \sin \sigma_n L \cosh \sigma_n L$$
$$- \left(\frac{h_o h_i}{2\sigma_n^2 k w^2} - 1\right) \cos \sigma_n L \sinh \sigma_n L$$
$$+ \left(\frac{h_o + h_i}{\sigma_n k w}\right) \sin \sigma_n L \sinh \sigma_n L \qquad (3.5.19)$$

$$\phi_n = \tan^{-1} \frac{Z_n}{Y_n} \qquad (3.5.20)$$

Sin ϕ_n has the sign of Z_n

Cos ϕ_n has the sign of Y_n

The rate of heat transfer to interior is given by

$$q_i = h_i\ (t_{w,i} - t_i) \qquad (3.5.21)$$

by equations

$$q_i = U\{[t_{e,m} + \lambda_1 t_{e,1} \cos(w_1 t - \phi_1 - \psi_1)$$
$$+ \lambda_2\ t_{e\ 2} \cos\ (w_2 t - \phi_2 - \psi_2)] - t_i \qquad (3.5.22)$$

where

$$\lambda_n = V_n/U \qquad (3.5.23)$$

Equivalent Temperature Difference

The form of equation (3.5.22) is interesting. Although q_i may be continually changing, it may be calculated by multiplying the overall coefficient U for steady state heat transmission by an equivalent temperature difference which accounts for the periodic variation of sol-air temperature te and for the heat storage characteristics of the wall. Thus equation (3.5.22) can

be written as

$$q_i = U \Delta T_{EQ} \tag{3.5.24}$$

where,

$$\Delta T_{EQ} = [t_{e,m} + \lambda_1 t_{e,1} \cos (w_1 t - \psi_1 - \phi_2) + \lambda_2 t_{e,2} \cos (w_2 t - \psi_2 - \phi_2)] - t_i \tag{3.5.25}$$

Mackey and Wright in their paper have given a procedure to reduce a composite wall into an equivalent homogeneous wall. They have proposed following conversion equations

$$(L/K)\ \text{Equivalent} \approx (L/K)_{\text{inside}} + (L/K)_{\text{outside}} + (L/K)_{\text{middle1}} + (L/K)_{\text{middle2}} \tag{3.5.26}$$

$(k\rho C)$ equivalent

$$= \frac{1}{(L/K)_{\text{equivalent}}} [1.1 (L/K)_{\text{inside}} (k\rho C)_{\text{inside}} + 1.1\ (L/K)_{\text{middle1}} (k\rho C)_{\text{middle1}} \ldots]$$

$$+ \frac{(k\rho C)_{\text{outside}}}{(L/K)_{\text{equivalent}}} [(L/K)_{\text{outside}} - 0.1\ (L/K)_{\text{middle 1}} - 0.1\ (L/K)_{\text{middle2}} \ldots]$$

In calculations of equivalent temperature differences these propositions have been assumed.

Computer program for calculation of these equivalent temperature differences is presented in Chapter 4. Results for various wall and roof on constructions used in India and for six cities (covering all latitudes for Indian cities) are presented in Chapter 5.

4.4 Computer Program for System Load Calculations

In this section, scheme of the computer program developed for calculation of cooling loads is presented.

Scheme for Input of Physical Characteristics of the Structure

Following assumptions have been made with regard to space to be airconditioned.

(1) All the spaces on any one storey have same heights.

(2) Spaces in the building (i.e. rooms, kitchen, lav, varandahs etc) are quadrilateral in shape.

(3) All outer walls of the structure are made of same construction material.

(4) All inner walls of the structure are made of same construction materials.

Direction of North must be laid on the plan of building. A right hand co-ordinate system is chosen on the plan as shown in Figure 4.4.1

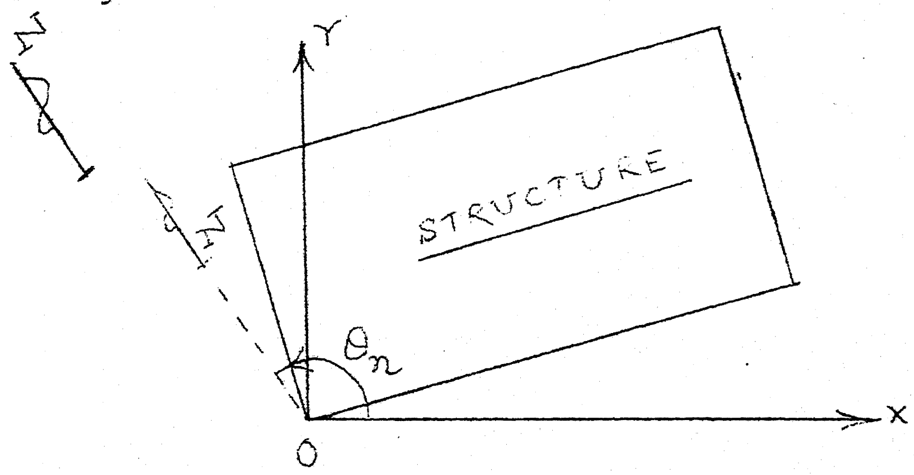
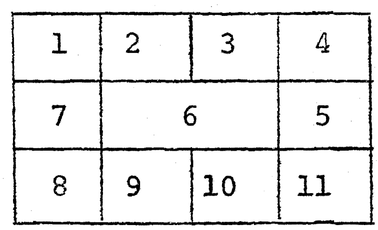


Figure 4.4.1

θ_n is the angle of North measured counter clockwise from X-axis. A node is defined as a point in plan where two actual walls or imaginary walls may meet. Space to be airconditioned is divided into subspaces such that each space is either conditioned or unconditioned. Subspace may or may not be enclosed by walls but must be enclosed by four nodes where two walls or imaginary walls may meet in plan.

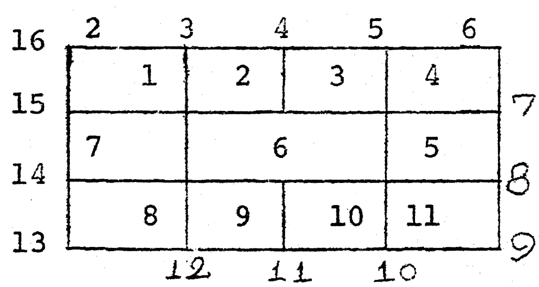
Each subspace is numbered distinctly starting from 1 to total number of subspaces (as shown in Figure 4.4.2)



Total No. subspaces = 11

Figure 4.4.2

All the nodes are marked in plan of each story. All the outer nodes are numbered starting from 2 in sequence. Node No. 2 is numbered again while closing the loop.



Total No. of outer Nodes = 14

Figure 4.4.3

In Figure 4.4.3 Node 2 has been renumbered 16. Rest of the nodes are numbered in continuation of the outer node as shown in Figure 4.4.4.

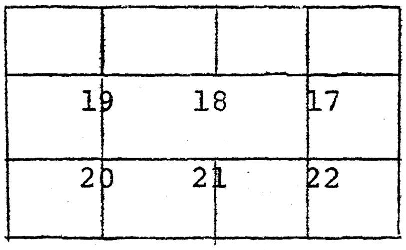


Figure 4.4.4

Coordinates X,Y are found from the plans for every node. Each subspace is associated with 4 nodes (which enlcose the space) following clockwise sequence. For example subspace 2 is surrounded by nodes 3,4,18,19. These nodes 3,4,18,19 appear

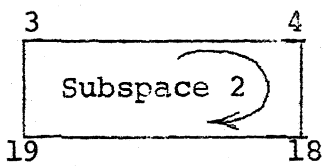


Figure 4.4.5

clockwise in the subspace.

Each subspace may be associated with four adjoining subspaces which have common walls with the subspace.

If any of the adjoining subspace is outside the building limits, it is termed 0.

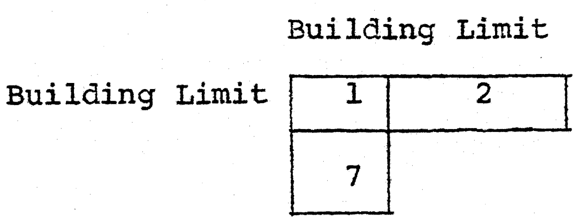


Figure 4.4.6

For example - subspace 1 is surrounded by subspace 2 and subspace 7 on two sides

and areas outside the building limits on the other two sides. Therefore adjoining spaces of subspace 1 will be known as 2,7,0,0. Conditioned spaces are denoted by

NCO = 1

and unconditioned spaces by

NCO = 0.

For those subspaces for which roof load is to be accounted

NROOF = 1

If roof load is not be accounted

NROOF = 0.

[For top floor NROOF = 1, for all subspaces].

Windows and doors for each outer walls are numbered. For example outer wall 2-3 contains two windows numbered 1 and 2

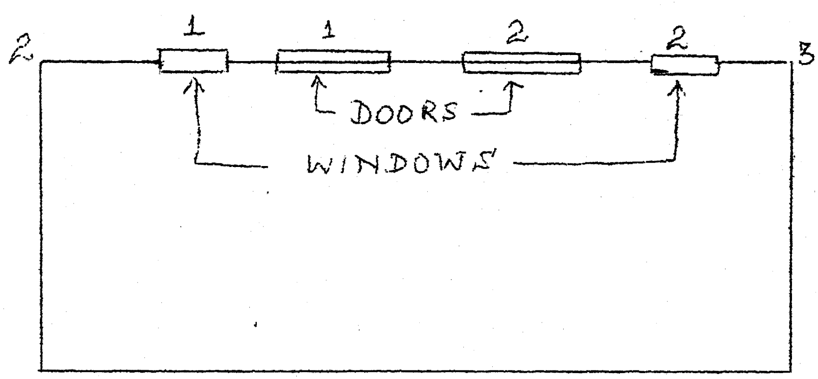


Figure 4.4.7

and two doors numbered 1 and 2. Length and height of windows are denoted by NWL (N,N1,N2) and NWH(N,N1,N2) where N and N1 are two nodes of wall in which window appears.

N2 is the number of windows in that wall.

For above example -

NWL (2,3,1)	for window 1,	NWL (2,3,2)	for window 2.
NWH (2,3,1)		NWH (2,3,2)	

Similar nomenclature has been adopted for doors in the outer walls.

TABLE 4.1: WALL CHARACTERISTICS REPRESENTED BY INPUT VARIABLE 'NWA'.

NWA	Type of Wall	U	$k\rho c_p$	L/k
1.	3" Cintered Aggregate Solid brick wall with plaster on both sides.	0.568	6.1512	0.8
2.	3" Brick + 2" Air space + 3" brick	0.328	3.427	3.87
3.	13 1/2" Solid brick wall with plaster on both sides	0.344	3.94	2.90
4.	1/2" plaster + 1 1/2" thermocole + 4 1/2" Brick + 1/2" plaster.	0.18	2.22	4.40

TABLE 4.2: ROOF CHARACTERISTICS REPRESENTED BY INPUT VARIABLE 'NT'.

NT	Type of roof	U	$k\rho c_p$	L/k
1.	1" Sprayed asbestos between galvanised iron sheets.	0.281	0.25	2.98
2.	4 1/2" Reinforced Concrete Cement + 4 1/2" lime.	0.468	34.9	0.75
3.	4 1/2" RCC + 1/2" plaster	0.665	31.01	0.47

TABLE 4.3: GLASS CHARACTERISTICS REPRESENTED BY INPUT-VARIABLE 'NG'.

Ng NG	1		2		3	
j	α_j	t_j	α_j	t_j	α_j	t_j
1.	0.01154	-0.00885	0.01838	-0.01201	0.01406	-0.00835
2.	0.77674	2.71235	1.92497	2.13037	4.15958	0.92766
3.	-3.94657	-0.62062	-8.89134	-1.13834	-15.06279	2.15721
4.	8.57881	-7.07329	18.40197	-10.07925	27.18492	- 8.71429
5.	-8.38135	9.75995	-17.48648	12.44162	-23.88518	9.87152
6.	3.01188	-3.89922	6.17544	- 4.83285	8.03650	- 3.73328

TABLE 4.4: INFILTRATION IN CFM PER LINEAR FOOT OF CRACK THROUGH WINDOWS REPRESENTED BY INPUT VARIABLES 'NW 11' AND 'NW 12'.

NW 12			1	2	3	4	5	6
NW 11	Type of Window	Size of Crack	Wind velocity in mph 5	10	15	20	25	30
1.	Industrial Pivoted	1/16"	0.87	1.80	2.9	4.1	5.1	6.2
2.	Architectural Projected	1/32"	0.25	0.60	1.03	1.43	1.86	2.3
3.	Architectural Projected	3/64"	0.33	0.87	1.47	1.93	2.5	3.0
4.	Residential Casement	1/64"	0.10	0.30	0.55	0.78	1.00	1.23
5.	Residential Casement	1/32"	0.23	0.53	0.87	1.27	1.67	2.10
6.	Heavy Casement Section Projected	1/64"	0.05	0.17	0.30	0.43	0.58	0.80
7.	Heavy Casement Section Projected	1/32"	0.13	0.40	0.63	0.90	1.20	1.53
8.	Hollow Metal-Vertically Pivoted	1/32"	0.50	1.46	2.40	3.10	3.70	4.00

TABLE 4.5: INFILTRATION IN CFM PER LINEAR FOOT OF CRACK THROUGH DOORS REPRESENTED BY INPUT VARIABLES 'NDOR 1' AND 'NDOR 2'.

NDOR 2			1	2	3	4	5	6
NDOR 1	Type of WDoor	Size of Crack	Wind velocity in mph					
			5	10	15	20	25	30
	GLASS DOOR - HERCULITE							
	1. Good Installation	1/8"	3.2	6.4	9.6	13.0	16.0	19.0
	2. Average Installation	3/16"	4.8	10.0	14.0	20.0	24.0	29.0
	3. Poor Installation	1/4"	6.4	13.0	19.0	26.0	26.0	38.0
	ORDINARY WOOD OR METAL							
	4. Well fitted W.strip	1/4"	0.45	0.60	0.90	1.3	1.7	2.1
	5. Well fitted No W.strip	1/4"	0.90	1.2	1.8	2.6	3.3	4.2
	6. Poorly fitted No W.strip	1/4"	0.90	2.3	3.7	5.2	6.6	8.4

TABLE 4.6: VENTILATION STANDARDS IN CFM PER PERSON FOR VARIOUS APPLICATIONS REPRESENTED BY INPUT VARIABLES NV AND NV1.

NV			1	2
			CFM PER PERSON	
NV1	Application	Smoking	Recommended	Minimum
1.	Apartment (Average)	Some	20	15
2.	Apartment (De Luxe)	Some	30	25
3.	Banking Space	Occasional	10	7.5
4.	Beauty Parlors	Occasional	10	7.5
5.	Cocktail Bars	Heavy	30	25
6.	Directors Rooms	Extreme	50	30
7.	Drug Stores	Considerable	10	7.5
8.	Hospitals: Operating Rooms	None	60	50
9.	Private Rooms	None	30	25
10.	Wards	None	20	15
11.	Hotel Rooms	Heavy	30	25
12.	Laboratories	Some	20	15
13.	Meeting Rooms	Very Heavy	50	30
14.	Office: General	Some	15	10
15.	Private	None	25	15
16.	Private	Considerable	30	25
17.	Restaurant: Cafeteria	Considerable	12	10
18.	Theater	None	7.5	5

TABLE 4.7: HEAT GAIN FROM PEOPLE REPRESENTED BY INPUT VARIABLES NP AND NP1.

NP		1		2		3		4		5	
NP 1	Degree of Activity	ROOM DRY-BULB TEMPERATURE									
		82 F		80 F		78F		75F		70F	
		S*	L**	S	L	AS	L	S	L	S	L
1.	Seated at rest	175	175	195	155	210	140	230	120	260	90
2.	Seated,very light work	180	220	195	205	215	185	240	160	275	125
3.	Office Worker	180	270	200	250	215	235	245	205	285	165
4.	Sedentary work	190	360	220	330	240	310	280	270	320	230
5.	Light bench work	190	560	220	530	245	505	295	455	365	385
6.	Moderate work	220	630	245	605	275	575	325	525	400	450
7.	Walking 3 mph	270	730	300	700	330	670	380	620	460	540
8.	Heavy work	450	1000	465	985	485	965	525	925	605	845

S* refers to Sensible heat gain in Btu/hr.

L** refers to Latent heat gain in Btu/hr.

```
C*********************************************************************************
C     THIS PROGRAM CALCULATES THE AIR CONDITIONING LOADS FOR
C     SYSTEM DESIGN. THE STRUCTURE FOR WHICH THE LOADS ARE
C     REQUIRED ,MAY BE OF ANY DIMENSIONS. IF THERE ARE MORE
C     THAN TWENTY ROOMS ON A FLOORS, THE SAME SHOULD BE DIVIDED
C     INTO SMALLER SUBSPACES SUCH THAT EACH SUBSPACES CONTAINS
C     TWENTY OR LESS THAN TWENTY ROOMS.
C*********************************************************************************
      DIMENSION NROOF(20)
      COMMON/DHANDE/LAT
      COMMON/KOHLID/ALANG(20,4)
      COMMON/KOHLI2/NR
      COMMON/KOHLI7/AREARO(20),NOWN(20)
      COMMON/KOHLI/AREAW(20,4),AREADO(20,4),AREAGL(20,4)
      CALL FLUN(10000)
     REAL LAT
      DIMENSION TO(24),NNR(20),NOS(20),NONS(20),HT(20),HSTORY(20),NN(50
     1,4),X(200),YU200),NADA(50,4),  NCO(50),NW(20,20),ND(20,20),NCHANG(
     250),NOP(50),VEN(50),SHEAT(50),HEATL(50),HEROOM(50),ALPHA(3),NOR(4)
      COMMON/ASER/TO
      READ 16,(NOR(I),I=1,4)
      READ 14, NALPHA
      PI=4.*ATAN(1.)
      READ 13,LAT,NDAY
      LAT=LAT*PI/180.
13    FORMAT(F10.2,I4)
14    FORMAT(I1)
16    FORMAT(4I3)
      READ11, MAT,MATD,MATW
11    FORMAT(3I2)
     READ 777,(TO(I),I=1,24)
777  FORMAT(12F6.1)
      READ10,THETAN,NS
10    FORMAT(F10.4,I5)
      READ12,(NNR(I),NOS(I),NONS(I),HT(I),I=1,NS)
12    FORMAT(3I5,F10.2)
      DO 15 IJ=1,NS
      NR=NNR(IJ)
      MOUT=NOS(IJ)+1
      NON=NONS(IJ)
      READ30,((NN(N,I),I=1,4),N=1,NR)
30    FORMAT(16I5)
      READ40,(X(I),Y(I),I=2,NON)
40    FORMAT(10F8.2)
      READ50,((NADA(N,I),I=1,4),N=1,NR)
50    FORMAT(20I4)
      READ101,(NROOF(N),N=1,NR)
101   FORMAT(40(1I1,1X))
```

```
      READ 100,(NCO(N),N=1,NR)
 100   FORMAT(40I2)
       READ60,(NW(I-1,I),I=3,NOUT)
       K=NOUT-1
       NW(K,2)=NW(K,NOUT!
 60    FORMAT(40I2)
      READ 80,(ND(I-1,I),I=3,NOUT)
       ND(K,2)=ND(K,NOUT)
 80    FORMAT(40I2)
C      READ210,(NCHANG(N),NOP(N),VEN(N),SHEAT(N),HEATL(N),N=1,NR)
 210   FORMAT(2I5,3F10.4)
       REAL NWL(20,20,3),NWH(20,20,3),NDL(20,20,3),NDH(20,20,3)
       DO 110 I=3,NOUT
       IF(NW(I-1,I).EQ.0) GO TO 11
       J=NW(I-1,I)
       READ130,(NWL(I-1,I,M),NWH(I-1,I,M),M=1,J)
 130   FORMAT(10F8.2)
 110   CONTINUE
       K=NOUT-1
       M=NW(K,NOUT)
       IF(M.EQ.0) GO TO 401
       DO 111 I=1,M
       NWL(K,2,I)=NWL(K,NOUT,I)
       NWH(K,2,I)=NWH(K,NOUT,I)
 111   CONTINUE
 401   CONTINUE
       DO 112 I=3,NOUT
       IF(ND(I-1,I).EQ.0) GO TO 112
       J=ND(I-1,I)
       READ130,(NDL(I-1,I,M),NDH(I-1,I,M),M=1,J)
 112   CONTINUE
       K=NOUT-1
       M=ND(K,NOUT)
       IF(M.EQ.0) GO TO 402
       DO 114 I=1,M
       NDL(K,2,I)=NDL(K,NOUT,I)
       NDH(K,2,I)=NDH(K,NOUT,I)
 114    CONTINUE
 402   CONTINUE
       NOUT=NOUT-1
       DO 150 N=1,NR .
       NOWN(N)=0
       AREARO(N)=0.
      IF(NCO(N).EQ.0)GO TO 150
       I1=0
 173   I1=I1+1
       IF(I1.EQ.4) GO TO 181
       J=NN(N,I1)
```

```
     1K)-Y(L))**2)**0.5)
       AREARO(N)=AREAR
       PRINT998,AREAR
 998   FORMAT(2X F10.2)
 150   CONTINUE
       CALL TOTAL
 15    CONTINUE
       STOP
       END
C*******************************************************************************
C     THIS SUBROUTINE EVALUATES THE INCLINATION O  OF EACH WALL
C     FROM THE X-AXIS IN ANTI CLOCKWISE DIRECTION .
C     THE INCLINATION OF NORTH FROM X-AXIS IS ALSO EVALUATED.
C*******************************************************************************
$IBFTC  ANG
       FUNCTION ANG(ZR,ZI)
       PI=4.*ATAN(1 )
       CALL FLUN(10000)
       IF(ZR.EQ.0..AND.ZI.LT.0.) ANG=-90.
       IF(ZR.EQ.0..AND.ZI.GT.0.) ANG=90.
      IF(ZR.EQ.0.)RETURN
       P=ABS(ZI/ZR)
       ANG=180./PI*ATAN(P)
       IF((ZR.LT.0.).AND.(ZI.GE.0.)) ANG=180.-ANG
       IF((ZR.LT.0.).AND.(ZI.LT.0.)) ANG=180.+ANG
       IF((ZR.GT.0.).AND.(ZI.LE.0.)) ANG=360.-ANG
       RETURN
       END
C*******************************************************************************
C     SUBROUTINE CALCULATES EQUIVALENT TEMPERATURE DIFFERENTIALS
C     FOR VARIOUS WALLS.ROOF.AND WALLS.
C*******************************************************************************
$IBFTC DILIP
       SUBROUTINE HEAT(NANA,NANI,IWALL)
       COMMON/DILIP7/AHT,BSB,CW
       COMMON/KOHLI1/ OW(24),OD(24),OL(24)
       COMMON/KOHLID/ALANG(24)
       DIMENSION FS(24)
       COMMON/DILIP6/FS
       COMMON/PROG1/ROCPK,XLBYK,U
      COMMON/RAJ/ NG,NOP,NP,NP1,NDOR,NDOR1,NW11,NW12,NW21,NW22,NV,NV1
       COMMON/AJAY/NWA
       COMMON/RAK/MT
       CALL FLUN(10000)
       COMMON/DILIP5/GLASSA(6),GLASST(6),Q(24),HOG,HIG
       COMMON/ASER/TO
       DIMENSION  IT(25)
        PI=4.*ATAN(1.)
```

```
      COMMON/SUB/A,B,C,DEC
      DIMENSION TO(24),TEQ(24)
      AHT=3.0
      BSB=0.5
      CW=3.0
      COMMON/DHANDE/LAT
      REAL KRCPR,KRCPW,LBYKR,LBYKW,LAT
      PHAI=0.
      WALANG=ALANG(NANA,NANT)
      IF(IWALL.EQ.5) WALANG=PI
      TINSDE=75.
      HOW=6.0
      HI=4.0
      HOR=1.6
      NDATE=615
      NDATAP=24
      ALPHA=0.7
      ALPHAR=0.5
      CALL DATAG(NG)
      HOG=3.0
      HIG=1.46
      IF(IWALL.EQ.5) PHAI=PI/2.
      CALL DECLN(NDATE)
      IF(IWALL.NE.5) GO TO 201
      HO=HOR
      CALL DATR(NT)
      ALPHAW=ALPHAR
      GO TO 202
201   HO=HOW
      ALPHAW=ALPHA
      CALL DAT(NWA)
202   CALL FURIER(NDATE,LAT,ROCPK,XLBYK,HO,HI,U,WALANG,PHAI,NDATAP,6,
     1 TO,ALPHAW)
      DO 205 ITIM=1,24
      TIME=ITIM
      IT(ITIM)=ITIM
      CALL CALCUL(TIME,TEQL,TSAL,6)
205   TEQ(ITIM)=TEQL
      DO 310 I=1,24
441   FORMAT(20X,F15.7)
      PRINT 116  IT(I),TEQ(I),Q(I)
      QW(I)=U*(TEQ(I)-TINSDE)
      QD(I)=CW(I)
310   CONTINUE
116   FORMAT(4X I2,10X,F10.2,10X,F10.2)
210   CONTINUE
      RETURN
```

```
      END
$IBFTC FURIER
       SUBROUTINE FURIER(NDE,LAT,KROCP,LBYK,HO,HI,U,WO,PHI,NDATA,NHARM,TO
      1   ,ALPHAW)
C     THIS SUBROUTINE CALCULATES THE COEFFICIENTS OF THE FOURIER SERIES
C     OF TEO AND TSOL.
        COMMON/KOHLI1/ QU(24),QD(24),QL(24)
         COMMON/PI1/PI
        CALL FLUN(10000)
        DIMENSION FS(24)
        COMMON/DILIP6/FS
        COMMON/DILIP7/AHT,BSB,CW
         COMMON/SUB/A,B,C,DEC
        COMMON/DILIP5/GLASSA(6),GLASST(6),Q(24),HOG,HIG
        UF=1./(1./HIG+1./HOG)
         COMMON TM(10),TN(10),TEM,TEQ(10),SI(10),PHEE(10),XLAMDA(10)
         DIMENSION TO(NDATA)
         REAL ID,IDH,IDN,LAT,KROCP,LBYK
         DO 50 L=1,NHARM
         TM(L)=0.
   50    TN(L)=0.
         HSUN=ARCOS(-TAN(LAT)*TAN(DEC))
         IDN(BETA)=A/EXP(B/SIN(BETA))
         TEM=0.
         DO 100 I=1,NDATA
         X=I
        ELPHA=0.
        TRA=0.
        ELPHAD=0.
        TRAD=0.
         H=ABS(12.-X)*PI/12.
         BETA=ARSIN(COS(LAT)*COS(DEC)*COS(H)+SIN(LAT)*SIN(DEC))
         COGAMA=(COS(LAT)*SIN(DEC)-COS(DEC)*SIN(LAT)*COS(H))/COS(BETA)
         GAMA=ARCOS(COGAMA)
  999   FORMAT(2X 10(F10.2,1X))
         IF(I.GT.12) ALPHA=ABS(WO-GAMA)
         IF(I.LE.12)ALPHA=ABS(2.*PI-WO-GAMA)
         THETA=ARCOS(COS(BETA)*COS(ALPHA)*COS(PHI)+SIN(BETA)*SIN(PHI))
         IF(PHI.EQ.PI/2.)THETA=PI/2.-BETA
  998   FORMAT(2X 2(F10.2))
         ID=IDN(BETA)*COS(THETA)
         IDH=C*IDN(BETA)
         IF(ID.LT.0.)ID=0.
         DATA RHO/0.2/
         REAL IH,ITOTAL
         IH=IDN(BETA)*SIN(BETA)+IDH
         IF(PHI.EQ.PI/2.)IH=0.
       IF(PHI.LE.PI/4.)ITOTAL=ID+CONST(THETA)*IDH+RHO*IH/2.
```

```
      IF(PHI.GT.PI/4.)ITOTAL=ID+IDH+RHO*IH/2.
        IF(H.GT.HSUN)ITOTAL=0.
        TE=ITOTAL*ALPHAW/HO+TO(I)
       RIR=RHO*IH/2.
       IF(PHI.LE.PI/4.)        IDH=CONST(THETA)
       IF(H.GT.HSUN)       ID=0.
       IF(H.GT.HSUN)   RIR=0.
       IF(H.GT.HSUN)    IDH=0.
       DELTA=ATAN(TAN(BETA)/COS(ALPHA))
       TAND=TAN(DELTA)
       TANA=TAN(ALPHA)
       TANAD=TANA*TAND
       R1=BSR/AHT
       R2=BSR/CW
       FS(I)=1.-R1*TAND-R2*TANA+R1*R2*TANAD
       IF(FS(I).LT.0.) FS(I)=0.
       IF(FS(I).GT.1.)    FS(I)=1.
       DO 603 KN=1,6
       XN=KN
       ELPHA=GLASSA(KN)*COS(THETA)**(KN-1)+ELPHA
       TRA=GLASST(KN)*(COS(THETA)**(KN-1))+TRA
       ELPHAD=2.*GLASSA(KN)/(XN+1.)+ELPHAD
       TRAD=2.*GLASSA(KN)/(XN+1.)+TRAD
603    CONTINUE
       TIN=75.
       Q(I)=(TRA*ID+TRAD*IDH+TRAD*RIR)+(ELPHA*ID+ELPHAD*IDH+ELPHAD
     1(1.+HOC/HIC)+UF*(TO(I)-TIN)
       QL(I)=Q(I)
        TEM=TEM+(1./24.)*TE
        X=X*PI/12.
        DO 60 J=1,NHARM
        Z=J
        Z=Z*X
        TM(J)=TM(J)+TE*COS(Z)/12.
60      TN(J)=TN(J)+TE*SIN(Z)/12.
100     CONTINUE
        DO 110 I=1,NHARM
        SAI=ATAN(ABS(TN(I)/TM(I)))
        X=I
        WI=PI*X/12.
        TFQ(I)=SQRT(TM(I)**2+TN(I)**2)
        IF((TN(I).GE.0.).AND.(TM(I).GE.0.))SI(I)=SAI
        IF((TN(I).GT.0.).AND.(TM(I).LT.0.))SI(I)=PI-SAI
        IF((TN(I).LT.0.).AND.(TM(I).GT.0.))SI(I)=-SAI
        IF((TN(I).LT.0.).AND.(TM(I).LT.0.))SI(I)=P9+SAI
        COF1=HO*HI/(WI*KROCP)
        COF2=(HO+HI)/SQRT(WI*KROCP/2.)
997    FORMAT(2X 2(F10.2,2X))
```

```
      ANG=SQRT(WI*KROCP/2.)*LBYK
       YI=(COF1+1.)*COS(ANG)*SINH(ANG)+(COF1-1.)*SIN(ANG)*COSH(ANG)
     1 +COF2*COS(ANG)*COSH(ANG)
       ZI=(COF1+1.)*SIN(ANG)*COSH(ANG)+(1.-COF1)*COS(ANG)*SINH(ANG)
     1 +COF2*SIN(ANG)*SINH(ANG)
       VI=HO*HI/(SQRT(WI*KROCP/2.)*SQRT(YI*YI+ZI*ZI))
       PHAI=ATAN(ABS(ZI/YI))
       IF((ZI.GE.0.).AND.(YI.GE.0.))PHEE(I)=PHAI
       IF((ZI.LT.0.).AND.(YI.LT.0.))PHEE(I)=PI+PHAI
       IF((ZI.GT.0.).AND.(YI.LT.0.))PHEE(I)=PI-PHAI
       IF((ZI.LT.0.).AND.(YI.GT.0.))PHEE(I)=-PHAI
  110  XLAMDA(I)=VI/U
 996  FORMAT(2X 2(F10.2,2X))
 995  FORMAT(2X 2(F10.2,2X))
 991  FORMAT(2X 2(F10.2,2X))
       RETURN
       END
$IBFTC CALCUL
      SUBROUTINE CALCUL(TIME,TEQL,TSOL,NHARM)
C     THIS SUBROUTINE CALCULATES THE SOL AIR TEMP. AND THE EQVLT. TEMP.,
C        ONCE THE COEFFICIENTS OF THE HARMONIC SERIES HAVE BEEN COMPUTED
C        BY SUBROUTINE FURIER.
       COMMON/PI1/PI
       COMMON TM(10),TN(10),TEM,TEQ(10),SI(10),PHEE(10),XLAMDA(10)
      CALL FLUN(10000)
       TEQL=TEM
       TSOL=TEM
       DO 1900 NL=1,NHARM
       XNL=NL
       XNL=XNL*TIME*PI/12.
       TSOL=TSOL+TEQ(NL)*COS(XNL-SI(NL))
 1900  TEQL=TEQL+XLAMDA(NL)*TEQ(NL)*COS(XNL-SI(NL)-PHEE(NL))
       RETURN
       END
$IBFTC CONST
       FUNCTION CONST(THETA)
      X=COS(THETA)
      A=-.2
      IF(X.GT.A) GO TO 10
      CONST=.44
      RETURN
  10   CONST=.56+.437*X+.313*X*X
       RETURN
       END
C*********************************************************************
     THIS SUBROUTIE RETURNS BACK VALUES OF DECLINATION FOR PARTICULAR
     DAY. IT ALSO RETURNS VALUES OF CONSTANTS A,B,C FOR CALCUL.TION OF
     DIRECT AND DIFFUSED SOLAR RADIATION INTENSITIES.
```

```
C*******************************************************************************
$IBFTC DECLN
      SUBROUTINE DECLN(NDAY)
      COMMON/PI1/PI
      COMMON/SUB/A,B,C,DEC
      DIMENSION D(12,4),E(12),F(12),G(12)
      DATA E/390.,385.,376.,360.,350.,345.,344.,351.,365.,378.,387.,
     1 391./
      DATA F/.142,.144,.156,.18,.196,.205,.207,.201,.177,.160,.149,
     1 .142/
      DATA G/.058,.060,.071,.097,.121,.134,.136,.122,.092,.073,.063,
     1 .057/
      DATA D(1 1),D(1,2),D(1,3),D(1,4)/-23.1333,-22.33,-21.25,-19.833/
      DATA D(2 1),D(2,2),D(2,3),D(2,4)/-17.3,-15.217,-12.917,-10.45 /
      DATA D(3 1),D(3,2),D(3,3),D(3,4)/-7.85,-5.167,-2.417,0.35    /
      DATA D(4 1),D(4,2),D(4,3),D(4,4)/4.267,6.933,9.25,11.95     /
      DATA D(5 1),D(5,2),D(5,3),D(5,4)/14.85,16.883,18.635,20.233/
      DATA D(6 1),D(6,2),D(6,3),D(6,4)/21.95,22.733,23.283,23.45 /
      DATA D(7 1),D(7,2),D(7,3),D(7,4)/23.167,22.567,21.65,20.4167/
      DATA D(8 1),D(8,2),D(8,3),D(8,4)/18.2,16.31,14.8333,12.033 /
      DATA D(9 1),D(9,2),D(9,3),D(9,4)/3.55,5.967,3.316,0.6/
      DATA D(10,1),D(10,2),D(10,3),D(10,4)/-2.9,-5.6,-8.25,-10.8/
      DATA D(11,1),D(11,2),D(11,3),D(11,4)/-14.2T-16.367,-18.3,-19.983
     1 /
      DATA D(12,1),D(12,2),D(12,3),D(12,4)/-21.6833,-22.7333,-23.233,
     1 -23.45/
      I=NDAY/100
      J1=NDAY-100*I
      J=J1/7+1
      XJ=J1-(7*(J-1)+1)
      IF(J.NE.4)GO TO 10
      I1=I+1
      IF(I.EQ.12)I1=1
      DNEXT=D(I1,1)
      GO TO 15
   10 DNEXT=D(I,J+1)
   15 DEC=D(I,J)+XJ*(DNEXT-D(I,J))/7.
      A=E(I)
      B=F(I)
      C=G(I)
      DEC=DEC*ATAN(1.)*4./180.
      RETURN
      END
$IBFTC LOAD
C*******************************************************************************
C    THIS SUBROUTINE RETURNS BACK THE TOTAL COOLIN+ LOAD OF VARIOUS
C    SUBSPACES KNOWING THE THE COOLING LOAD FROM INDIVIDUAL SOURCES.
C*******************************************************************************
```

```
      SUBROUTINE  TOTAL
     COMMON/RAJ/ NG,NOP,NP,NP1,NDOR,NDOR1,NW11,NW12,NW21,NW22,NV,NV1
      COMMON/RAK/NT
      COMMON/AJAY/NWA
      READ420, NG,NOP,NP,NP1,NDOR,NDOR1,NW11,NW12,NW21,NW22,NV,NV1,NT,
    1NWA
420   FORMAT(20I2)
      COMMON/KOHLID/ALANG(20,4)
      DIMENSION QT(20,24)
      DIMENSION Q(24)
      COMMON/KOHLI/AREAW(20,4),AREADO(20,4),AREAGL(20,4)
      COMMON/KOHLI1/ QW(24),QD(24),QL(24)
      COMMON/KOHLI7/AREARO(20),NOWN(20)
      COMMON/KOHLI2/NR
      CALL FLUN(10000)
      DO 100 N=1,NR
      DO 105 IT=1,24
      Q(IT)=0.
105   CONTINUE
      IN=NOWN(N)
      IF(IN.EQ.0) GO TO 150
      DO 110 NN=1,IN
      CALL HEAT(N,NN,1)
      CALL GEN
      DO 120 IT=1,24
      Q(IT)=AREAW(N,IN)*QW(IT)+AREADO(N,IN)*QD(IT)+AREAGL(N,IN)*QL(IT)+
    1Q(IT)
120   CONTINUE
110   CONTINUE
150   IF(AREARO(N).EQ.0.) GO TO 160
      CALL HEAT(NR,2,5)
      DO 140 IT=1,24
      Q(IT)=Q(IT)+AREARO(N)*QW(IT)
140   CONTINUE
160   CONTINUE
      DO 130 IT=1,24
      QT(N,IT)=Q(IT)
130   CONTINUE
100   CONTINUE
      DO 180 IT=1,24
      PRINT 181 IT,(QT(N,IT),N=1,NR)
180   CONTINUE
181   FORMAT(1X I2,12(F7.1,2X))
      RETURN
      END
$IBFTC GCOFF
      SUBROUTINE DATAG(N)
      DIMENSION GLASSB(6,3),GLASST(6,3)
```

```
      COMMON/DILIPS/GLASSA(6),GLASST(6),Q(24),HOG,HIG
      DATA GLASSB/0.01154,0.77674,-3.94637,8.57881,-8.38135,3.01188,0.0
     11838,1.92437,-8.89134,18.40197,-17.48848,6.17544,0.01406,4.15958,-
     215.06279,27.18492,-23.88518,8.03650/
      DATA  GLASSU/-0.00885,2.71235,-0.62062,-7.07329,9.75995,-3.89922,
     1-0.01201,2.13037,1.13834,-10.07925,12.44162,-4.83285,-0.00835,0.92
     2766,2.05721,-8.71429,9.87152,-3.73328/
      DO 100 I=1,6
      GLASSA(I)=GLASSB(I,N)
      GLASST(I)=GLASSU(I,N)
 100  CONTINUE
      RETURN
      END
$IBFTC CDOOR
      SUBROUTINE DATDOR(N,N1,CFMD)
      DIMENSION DOOR(3,5)
      DATA DOOR/1.6,9.0,2.0,10.5,30.0,13.0,12.6,36.0,15.5,14.2,40.5,17.
     15,17.3,49.5,21.5/
      CFM=DOOR(N,N1)
      RETURN
      END
$IBFTC SINGH
      SUBROUTINE DATAV(N,N1,VEN)
      DIMENSION IVEN(19,2)
      DATA IVEN/20,30,10,10,30,50,10,50,30,20,30,20,15,25,30,12,15,8,15
     1,15,25,8,8,25,30,8,50,25,15,25,15,10,15,20,10,12,8,10/
      VEN=IVEN(N,N1)
      RETURN
      END
$IBFTC DOR1
      SUBROUTINE DATD(N,N1,CFMD)
      DIMENSION CDOOR(7,6)
      DATA CDOOR/3.2,4.8,6.4,0.45,0.90,0.90,3.2,6.4,10.0,13.0,0.60,1.2,
     12.3,6.4,9.6,14.0,19.0,0.90,1.30,3.70,9.6,13.0,20.0,26.0,7.3,2.6,5.
     22,13.0,16.0,24.0,26.0,1.7,3.3,6.6,16.0,19.0,29.0,38.0,2.1,4.2,8.4,
     319.0/
      CFMD=CDOOR(N,N1)
      RETURN
      END
$IBFTC ROOF
      SUBROUTINE DATR(N)
      REAL LBYKR(3),KRCPR(3)
      DIMENSION UR(3)
      COMMON/PROG1/ROCPK,XLBYK,U
      DATA UR/0.281,0.468,0.665/
      DATA KRCPR/0,25.34,9.31.01/
      DATA LBYKR/2.98,0.75,0.47/
      U=UR(N)
```

```
      ROCPK=KRCPR(N)
      XLBYK=LBYKR(N)
      RETURN
      END
$IBFTC WALL
      SUBROUTINE DAT(N)
      COMMON/PROG1/ROCPK,XLBYK,U
      REAL LBYKW(4),KRCPW(4)
      DIMENSION UW(4)
      DATA UW/0.568,0.328,0.344,0.18/
      DATA KRCPW/6.512,3.427,3.94,2.22/
      DATA LBYKW/0.8,3.87,2.90,4.40/
      U=UW(N)
      ROCPK=KRCPW(N)
      XLBYK=LBYKW(N)
      RETURN
      END
$ENTRY
```

4.2 COMPUTER PROGRAM FOR ESTIMATION OF DESIGN CONDITIONS

```
C*****************************************************************************
C       THIS PROGRAM ESTIMATES THETEMPERATURES AND RANGES BY T DISTRIBUTION
C*****************************************************************************
        DIMENSION IRS(10,10)
        D+MENSION ARAN(20',ATMAX(20),AWRAN(20),AWTMAX(20),ADUMMY(10)
        DIMENSION IRH(24),RH(24),APRS(10,10),PRS(10,10),WBT(24)
        DIMENSION DBT(24),IBT(24),TL'7,2),TMAX(10,7,2),RAN(10,7,2),WRAN(1
       10,7,2',WTMAX(10,7,2),RANG(7,2),WRANG(7,2),DRAN(10,7,2),DTMAX(10,7,
       22)
        READ40,CON
 40     FORMAT(F6.4)
        DO 51 I=1 10
        DO 51 J=1 7
        DO 51 K=1 2
        TM(J,K)=0.
        TMAX(I,J,K)=0,
        RAN(I,J,K)=0.
        WTMAX(I,J K)=0.
        WRAN(I,J,K)=0=
        RANG(J,K)=0.
        WRANG(J,K)=0.
 50     FORMAT(I2 5I1,1X,24I3)
 51     CONTINUE
        DO 27 J=1 4
        DO 27 I=1 7
        APRS(I,J)=0.
 27     CONTINUE
        DO 28 KM=1,5
        READ 29,((IRS(I,J),J=1,4),I=1,7)
 29     FORMAT(20(I3,X))
        DO 30 J=1 4
        DO 30 I=1 7
        PRS(I,J)=IRS(I,J)
        APRS(I,J)=PRS(I,J)+APRS(I,J)
        IF(KM EQ.5)APRS(I,J'=APRS(I,J)*CON/5.
 30     CONTINUE
 28     CONTINUE
 11     CONTINUE
 500    READ 50,IC,IY,IM,ID,IE,IU,(IBT(IT),IT=1,24)
        READ2,IIC IIY,IIM,IID,(IRH(IT),IT=1,24)
 2      FORMAT(I2 3I1,3X,24(I2,X))
        IF(IC.EQ.IIC AND.IY.EQ.IIY.AND.IM.EQ.IIM.AND.ID.EQ.II4) GO TO 25
        PRINT26,IC,IY,IM,ID
 26     FORM1T(20X,I2,3I1'
        GO TO 11
 25     DO 10 IT=1,24
        IF(IBT(IT).GE.100=AND.IBT(IT).LE.140.AND.IU.EQ.1) IBT(IT)=IBT(IT)
       1*10
```

```
      DBT(IT)=IBT(IT)
      RH(IT)=IRH(IT)
      DBT(IT)=DBTUIT)/10.
      IF(IC.EQ.33)  GO TO 1000
10    CONTINUE
      IF(IC.EQ.0) GO TO 11
      IJ=1
310   IF(IBT(IJ).EQ.0) GO TO11
      IF(DBT(IJ).GT.140=.AND IU.EQ.1) GO TO11
      IF(RH(IJ).EQ.0.) RH(IJ)=100.
      IF(DBT(IJ).GT.50..AND.IU.EQ.0) GO TO 11
      IF(IJ.EQ.24) GO TO14
      IJ=IJ+1
      IF(ABS(DBT(IJ)-DBT(IJ-1)).GT.15.0)GO TO 11
      IF(ABS( RH(IJ)- R8(IJ-1)).GT.22.) GO TO 11
      IF(IJ.LE.24D GO TO 310
14    CONTINUE
      IF(IU.EQ.1) GO TO 903
      DO 902 J=1,24
      DBT(J)=DBT(J)*9./5.+32.
902   CONTINUE
903   CONTINUE
      DO 33 N=1 24
      9F(N.LT.10.AND.N.7E.1) PR=APRS(IM-2,1)
      IF(N.LT.14.AND.N.GE.10) PR=APRS(IM-2,2)
      IF(N.LT.18.AND.N.7E.14) PR=APRS(IM-2,3)
      IF(N.LT.24.AND.N.7E.18) PR=APRS(IM-2,4)
         CALL     CONVRT(DBT, RH, PR, WBT, N )
33    CONTINUE
      IMAP=1
82    X=DBT(1)
      DO235J=1,23
      IF(X-DBT(J+1))230,230,235
230   X=DBT(J+1)
235   CONTINUE
      Y=DBT(1)
      DO 340J=1 23
      IF(Y-DBT(J+1)) 345,345,350
350   Y=DBT(J+1)
345   CONTINUE
340   CONTINUE
      RANGE=X-Y
      IF(IY.EQ.0) IY=10
      IF(ID.EQ.6)  ID=2
      IF(IMAP.EQ.1) RAN(IY,IM-2,ID)=X-Y
      IF(IMAP.EQ.1) TMAX(IY,IM-2,ID)=X
      IF(IMAP.EQ.2)  WRAN(IY,IM-2,ID)=X-Y
      IF(IMAP.EQ.2) WTMAX(IY,IM-2,ID)=X
```

```
      IMAP=IMAP+1
      IF(IMAP.GT.2) GO TO 81
      DO 34 I=1 24
      DRT(I)=WBT(I)
 34   CONTINUE
       GO TO 82
 81   CONTINUE
      IF(IC.NE.33)  GO TO 500
 1600 CONTINUE
      ICAL=1
      DO 52 J=1 7
      DO 52 K=1 2
      PRINT 715
 715  FORMAT(1H0)
  718 FORMAT( 20XT*PROBABILITY*,10W,*99.5*,3X,*99.0*,3X,*97.5*,3X,*95.0
     1*,3X,*90.0*,3X,*75.0*)
      PRINT 718
      PRINT 716  J,K
 716  FORMAT(20X,*MONTH  *,I2,*   DATE  *,I2)
      DO 106 I=1,10
      ARAN(I)=RAN(I,J.K)
      ATMAX(I)=TMAX(I,J,K)
      AWRAN(I)=WRAN(I,J,K)
      AWTMAX(I)=WTMAX(I,J,K)
 106  CONTINUE
      CALL  PARA(ATMAX    , 10, ADTMMY   , 1)
      PRINT 705
 705  FORMAT(50X,*  DRY BULB  TEMPERATURE*  )
       PRINT 702, (ADUMMY(I),I=1,6)
 702   FORMAT(40XT6F6.1)
      CALL  PARA(  ARAN   , 10, ADTMMY   , 2)
      PRINT 709
 709  FORMAT(50X,*  DRY BULB  RANGR    *)
       PRINT 702, (ADUMMY(I),I=1,6)
      CALL  PARA(AWTMAX   , 10, ADUMMY   , 1)
      PRINT 706
       PRINT 702, (ADUMMY(I),I=1,6)
 706  FORMAT(50X,* WET BULB TEMPERATURE *)
      CALL  PARA( AWRAN   , 10, ADTMMY   , 2)
      PRINT 707
       PRINT 702, (ADUMMY(I).I=1,6)
707   FORMAT(50X, *WET BULB RANGE    *)
 52   CONTINUE
      STOP
      END
$IBFTC SUB5
      SUBROUTINE PARA(X   ,IL   ,   ADUMMY   ,INO   )
      DIMENSION X(20),ADUMMY(10),T(10,6)
```

```
      DATA T/ 1.0T0.8165,0.7649,0.7407,0.7267,0.7176,0.7111,0.7064,0.70
     127,0.6998,3,0777,1.8856,1.6377,1.5332,1.4759,1.4398,1.4149,1.3968,
     21.3830,1.3722,6.3138,2.9200,2.3534,2.1318,2.0150,1.9432,1.8946,1.8
     3595,1.8331 1.8125,12.7062,4.0327,3.1824,2 7764,2.5706,2.4469,2.364
     46,2.3060,2.2622,2.2281,31.8207,6.9646,4.5407,3.7469,3.3649,3.1427,
     52=9980,2.8765,2.8214,2.7638,63.6574,9.9248,5.8409,4.6041,4.0322,3.
     67074,3.4995,3.3554,3.2498,3.*693/
      SIGMA=0.
      SIGX=..
      INTEGR=0
      DO 10 I=1 IL
      IF(X(I).NE.0.) INTEGR=INTEGR+1
      SIGX=X(I)+SIGX
 10   CONTINUE
      IF(INTEGR.EQ.0) XBAR=0.
      XN=INTEGR
      IF(INTEGR.NE.0)  XBAR=SIGX/XN
      DO 2. I=1 IL
      IF(X(I).EQ.0.) GO TO 20
      SIGMA=(XBAR-X(I))**2+SIGMA
 20   CONTINUE
      XN=INTEGR
      IF(INTEGR.GT.1) SIGMA=SIGMA/(XN-1.)
      SIGMA=SQRT(SIGMA)
      IF(INTEGR.LE.1) SIGMA=0.
      IF(INTEGR.LT.2)  PRINT102
 102  FORMAT(10X,*RESULTS ARE ABSURD *)
      NEW=INTEGR-1
       DO 100 I=1,6
      IF(INO.EQ.1) ADUMMY(I)=T(NEW,I)*SIGMA+XBAR
      IF(INO.EQ.2) ADUMMY(I)=XBAR SIGMA*T(NEW,I)
 100  CONTINUE
      RETURN
      END
$IBFTC SUB1
      SUBROUTINE CONVRT ( DRT, RHH, PR,TN, N )
      DI4ENSION TN(24)
      DIMENSION T(24),RHH(24),DRT(24)
      DBT=DRT(N)
      RH=RHH(N)
      DATA A,B,C,D/16.386396,0.00*37804,5656.,429.67/
      DATA E,F,G,+/3.560573,100.,0.2402,0.000014/
      DATA O,P,Q,R/50.0,0.444,1061.0,32.00/
      DATA S,V,U/0.11,0=62197,1.95/
      SATPR(T)=10.0**(A+B*T-C/(D+T)-E*ALOG((D+T)/F))
     1*(.49119)
      PS=SATPR(DBT)
      PA=PR*0.49119
```

```
      PR=PR*0.49119
      PHI=RH/100.
      WPRIME=0.622*PHI*PS/(PA-PS*PHI)
      I=1
      T(1)=DBT-15C
 20   HGSTAR=P*T(I)+Q
      HWSTAR=T(I)-R+S
      WSSTAR=V*SATPR(T(I))1(PR-SATPR(T(I)))
     1+(U*((T(I)+60.)**5))/(10.**15)
      8GPRI=P
      HWPRI=1.
      IF(T(I)-50.) 100,100,200
 100  CPSTAR=0.2402
      GO TO 300
 200   CPSTAR=0.2402+((0.0000014)*(T(I)-50.))
 300  CONTINUE
      WSSPRI=(V*PR*SATPR(T(I))*ALOG(10.)/((PR-SATPR(T(I)))**2))
     1*(B+C/((D+T(I))**2)-E/(D+T(I)))
     2+(5.*U*((T(I)+60.)**4))/(10.**15)
      W=WSSTAR-(DBT-T(I))*(CPSTAR/(HGSTAR-HWSTAR))
      AF=W-WPRIME
     FPRIME=WSSPRI+(CPSTAR/(HGSTAR-HWSTAR))
     1-(DBT-T(I))
     2*((HGSTAR-HWSTAR)*3PP(T(I))-CPSTAR*(HGPRI-HWPRI))
     3/((HGSTAR-HWSTAR)**2)
      T(I+1)=T(I)-AF/FPRIME
     I=I+1
 23   FORMAT(2X 4(F15.8,2X))
 21   FORMAT(2X 6(F15.8,1X))
 22   FORMAT(2X 4(F15.8,2X))
     IF(ABS(T(I)-T(I-1)).GT.0.001.OR.ABS(W-WPRIME).GT.0.00001) GO TO 20
      TN(N)=T(I)
 700  CONTINUE
 10   FORMAT(3F5.2)
 30   FORMAT(2X 2F15.8)
      RETURN
      END
$IBFTC SUB2
      FUNCTION CPP(T)
      IF(T-50.) 10,10,20
 10   CPP=0.
      RETURN
 20   CPP=0.0000014
      RETURN
      END
$ENTRY
```

4.3 COMPUTER PROGRAM FOR ESTIMATION OF HOURLY TEMPERATURE DISTRIBUTIC

```
C*****************************************************************************
C     CALCULATION OF OPTIMUM HOURLY TEMPERATURE DIFFERENTIALS
C     BY SOLUTION OF A SYSTEM OF LINEAR EQUATIONS APPLYING
C     LAGRANGIAN MULTIPLIER TECHNIQUE.
C     THE MAIN PROGRAM SCANS THE WHOLE DATA OF ALL STATIONS
C     AND SELECTS THE DAYS OF WHICH THR RANGE IS FIXED SAY 30.
C   IT ALSO CALCULATES THE NO.OF DAYS AND DIFFERENCE BETWEEN
C     ASSUMED CURVE AND A3TUAL READINGS.
C*****************************************************************************
      DIMENSION IRS(10,10)
      DIMENSION IRH(24),RH(24),APRS(10,10),PRS(10,10),WBT(24)
      DIMENSION H(26)
     DIMENSION DBT(24),IBT(24),M(100),AY(100)
      ILOP=1
      MAN=25
      DIMENSION SIGMAR(100,60),SIGMAP(100)
      DIMENSION A1(27,27),YR(100,24)
      DIMENSION B1(27),BA(27,1)
      COMMON/DILIP/A1
      DO 152 MM=1,100
      DO 152  NN=1,60
      SIGMAR(MM NN)=0.
      SIGMAP(MM)=0
152   CONTINUE
      READ40,CON
50    FORMAT(I2,I1,I1,I1,I1,I1,1X,24I3)
40    FORMAT(F6.4)
      DO 410 J=1,24
      DO 410 IRA=1,100
      M(IRA)=0
410   CONTINUE
      DO 27 J=1 4
      DO 27 I=1 7
      APRS(I,J)=0.
27    CONTINUE
      DO 28 KM=1,5
      READ29,((IRS(I,J),J=1,4),I=1,7)
29    FORMAT(20(I3,X))
      DO 30 J=1 4
      DO 30 I=1 7
      IF(IRS(I,J).LT.-00.AND.IRS(I,J).GT.0)IRS(I,J)=1000+IRS(I,J)
      PRS(I,J)=IRS(I,J)
      APRS(I,J)=PRS(I,J)+APRS(I,J)
      IF(KM.EQ.5)APRS(I,J)=APRS(I,J)*CON/5.
3_    CONTINUE
28    CONTINUE
11    CONTINUE
500   READ 50,IC,IY,IM,ID,IE,IU,(IBT(IT),IT=1,24)
```

```
      READ2,IIC,IIY,IIM,IID,(IRH(IT),IT=1,24)
2     FORMAT(I2 3I1,3X,24(I2,X))
51    FORMAT(5X I2,5I1,5X,24(I3,X))
21    FORMAT(5X I2,3I1,24(I2,X))
      IF(IC.EQ.IIC.AND.IY.EQ.IIY.AND.IM.EQ.IIM.AND.ID.EQ.IID) GO TO 25
      PRINT26,IC,IY,IM,ID
26    FORMAT(20X,I2,3I1)
      DIMENSION SHARMA(80)
      DATA RAO/1H /
986   READ 988,(SHARMA(I),I=1,80)
988   FORMAT(80A1)
      IF(SHARMA(7).EQ.RAO.AND.SHARMA(6).EQ.RAO) GO TO 986
      READ988,(RNS(I),I=1,80)
      DO 984 NI=1T5
      IF(RNS(NI).NE.SHARMA(NI))     GO TO 986
984   CONTINUE
      GO TO 500
      GO TO 11
25    DO 10 IT=1,24
      IF(IBT(IT).GE.100.AND.IBT(IT).LE.140.AND.IU.EQ.1) IBT(IT)=IBT(IT)
     1*10
      DBT(IT)=IBT(IT)
      RH(IT)=IRH(IT)
      DBT(IT)=DBT(IT)/10.
      IF(IC.EQ.33)  GO TO 1600
10    CONTINUE
      IF(IC.EQ.0) GO TO 11
      IJ=1
310   IF(IBT(IJ).EQ.0) GO TO11
      IF(DBT(IJ).GT.140..AND.IU.EQ.1) GO TO11
      IF(IRH(IJ).EQ.0) IRH(IJ)=100
      IF(RH(IJ).EQ.0.) RH(IJ)=100.
      IF(DBT(IJ).GT.50..AND.IU.EQ.0) GO TO 11
      IF(IJ.EQ.24) GO TO14
      IJ=IJ+1
      IF(ABS(DBT(IJ)-DBT(IJ-1)).GT.15.0)GO TO 11
      DUMMY=IRH(IJ)-IRH(IJ-1)
      IDUMMY=ABS(DUMMY)
      IF(IDUMMY.GT.22) GO TO 11
      IF(IJ.LE.24) GO TO 31
14    CONTINUE
      IF(IU.EQ.1) GO TO 903
      DO 902 J=1,24
      DBT(J)=DBT(J)*9./5.+32.
902   CONTINUE
903   CONTINUE
      IF(ILOP.EQ.1) GO TO81
      DO 33 N=1 24
```

```
      IF(N.LT.10.AND.N.GE.1) PR=APRS(IM-2,1)
      IF(N.LT.14.AND.N.GE.10) PR=APRS(IM-2,2)
      IF(N.LT.18.AND.N.GE.14) PR=APRS(IM-2,3)
      IF(N.LT.24.AND.N.GE.18) PR=APRS(IM-2,4)
        CALL     CONVRT(DBT, RH, PR, WBT, N )
 33   CONTINUE
      DO 34 I=1 24
      DBT(I)=WBT(I)
 34   CONTINUE
 81   X=DBT(1)
      DO235J=1,23
      IF(X-DBT(J+1))230,230,235
 230  X=DBT(J+1)
 235  CONTINUE
      Y=DBT(1)
      DO 34_J=1 23
      IF(Y-DBT(J+1)) 345,345,350
 350  Y=DBT(J+1)
 345  CONTINUE
 340  CONTINUE
      RANGE=X-Y
      IRA=RANGE+1.
      M(IRA)=M(IRA)+1
      IF(IRA.NE.MAN) GO TO 500
      N=M(IRA)
      DO 1_002 IH=1,24
      YR(N,IH)=DBT(IH)-Y
10002 CONTINUE
      DO 150 J=1,24
      SIGMAR(N,IRA)=(X-DBT(J))+SIGMAR(N,IRA)
      IF(J.EQ.24) SIGMAR(N,IRA)=SIGMAR(N,IRA)/23
 150  CONTINUE
      IF(IC.NE.33)  GO TO 500
 1600 CONTINUE
      MN=M(MAN)
      DO 151 KN=1,MN
      SIGMAP(MAN)=SIGMAR(KN,MAN)+SIGMAP(MAN)
 151  CONTINUE
      XM=MN
      SIGMA=SIGMAP(MAN)/XM
      TMAX=MAN
      TMIN=.
      CALL COEFF(TMAX,TMIN,YR,SIGMA,MN,B1)
      DO 10001 IN=1,27
      BA(IN,1)=B1(IN)
10001 CONTINUE
      PRINT 999 ((A1(I,J),J=1,27),I=1,27)
 999  FORMAT(4X 10(F10,2,2X))
```

```
      PRINT 998 (B1(I),I=1,27)
998   FORMAT(4X 10(F10.2,2X))
      CALL MATINV(A1,27,27,BA,1,1)
      PRINT 10004,(BA(IN,1),IN=1,27)
10004 FORMAT(10X,F13.4)
      PI=4.*ATAN(1.)
      W=PI/12.
      DO 995 IH=1,24
      H(IH)=IH
      FD=0.
      DO 994 IL=1,24
      XIL=IL
      IF(IL GT.12) FD=FD+BA(IL  ,1)*COS((XIL-12.)*W*H(IH))
      IF(IL.LT.12) FD=FD+BA(IL+1,1)*SIN(XIL*W*H(IH))
      IF(IL.EQ.24) FD=FD+BA(1,1)
994   CONTINUE
      PRINT 992  IH,FD
992   FORMAT(10X,I2,10X,F10.2)
995   CONTINUE
      STOP
      END
$IBFTC COEFF
C**********************************************************************
C     THIS SUBROUTINE GENERATES THE CO-EFFICIENTS OF THE ASSUMED
C     CURVE AND THEN PREPARES ALL THE COEFFICIENTS OF THE SYSTEM
C     OF LINEAR EQUATIONS.
C**********************************************************************
      SUBROUTINE COEFF(TMAX,TMIN,Y,SIGMA,IDAY,B1)
      DIMENSION A(28,28),B(28),H(25),Y(100,24)
      DIMENSION A1(27,27),B1(27)
      COMMON/DILIP/A1
      PI=4.*ATAN(1.)
      HMAX=15.
      HMIN=6.
      W=PI/12.
      DO 99 I=1 28
      DO 99 J=1 2
      B(I)=.
      A(I,J)=0.
99    CONTINUE
      DO 101 ID=1TIDAY
      DO 102  IH=1,24
      H(IH)=IH
      A(1.1)=A(1,1)+2.0
      B(1)=B(1)+Y(ID,IH) *2.
      DO 103 NR=2,25
      XR=NR 1
      IF(NR.GT.13) A(1,NR)=A(1,NR)+2.*COS((XR-12.)*W*H(IH))
```

```
      IF(NR.LE.13) A(1,NR)=A(1,NR)+2.*SIN(XR*W*H(IH))
103   CONTINUE
102   CONTINUE
101   CONTINUE
      A(1,26)=-1.
      A(1,27)=-1.
      A(1,28)=-24./23.
      DO 107 M=2,13
      XM=M-1
      DO 106 IH=1,24
      DO 105 ID=1,IDAY
      A(M,1)=A(M,1)+2.*SIN(XM*W*H(IH))
      DO 108 NR=2,25
      XR=NR-1
      IF(NR.GT.13) A(M,NR)=A(M,NR)+2.*COS((XR-12.)*W*H(IH))*SIN(XM*W*H(
     1IH))
      IF(NR.LE.13) A(M,NR)=A(M,NR)+2.*SIN(XR*W*H(IH))*SIN(XM*W*H(IH))
108   CONTINUE
      B(M)=B(M)+Y(ID,IH)*SIN(XM*W*H(IH))*2.
105   CONTINUE
     A(M,28)=A(M,28)-SIN(XM*W*H(IH))
106   CONTINUE
      A(M,28)=A(M,28)/23.
      A(M,26)=-SIN(XM*W*HMAX)+A(M,26)
      A(M,27)=-SIN(XM*W*HMIN)+A(M,27)
107   CONTINUE
      DO 110 M=14,25
      XM=M-13
      DO 112IH=1,24
      DO 111 ID=1,IDAY
      A(M,1)=A(M,1)+2.*COS(XM*W*H(IH))
      DO 113 NR=2,25
      XR=NR-1
      IF(NR.GT.13) A(M,NR)=A(M,NR)+2.*COS((XR-12.)*W*H(IH))*COS(XM*W*H(
     1IH))
      IF(NR.LE.13) A(M,NR)=A(M,NR)+2.*SIN((XR-00.)*W*H(IH))*COS(XM*W*H(
     1IH))
113   CONTINUE
      B(M)=B(M)+Y(ID,IH)*COS(XM*W*H(IH))*2.
111   CONTINUE
     A(M,28)=A(M,28)-COS(XM*W*H(IH))
112   CONTINUE
      A(M,28)=A(M,28)/23.
      A(M,26)=-COS(XM*W*HMAX)+A(M,26)
      A(M,27)=-COS(XM*W*HMIN)+A(M,27)
110   CONTINUE
      M=26
      A(M,1)=-1.
```

```
      DO 120 NR=2,25
      XR=NR-1
      IF(NR.GT.13) A(M,NR)=A(M,NR)-COS((XR-12.)*W*HMAX)
      IF(NR.LE.13) A(M,NR)=A(M,NR)-SIN(XR*W*HMAX)
120   CONTINUE
      B(M)=.TMAX
      M=27
      A(M,1)=-1.
      DO 121 NR=2,25
      XR=NR-1
      IF(NR.GT.13) A(M,NR)=A(M,NR)-COS((XR-12.)*W*HMIN)
      IF(NR.LE.13) A(M,NR)=A(M,NR)-SIN(XR*W*HMIN)
121   CONTINUE
      B(M)=-TMIN
      M=28
      A(M,1)=-24./23.
      DO 130 NR=2,25
      XR=NR.1
      DO 131 IH=1,24
      IF(NR.GT.13) A(M,NR)=A(M,NR)-COS((XR-12.)*W*H(IH))
      IF(NR.LE.13) A(M,NR)=A(M,NR)-SIN(XR*W*H(IH))
131   CONTINUE
      A(M,NR)=A(M,NR)/23.
130   CONTINUE
      B(M)=SIGMA-24./23.*TMAX
      DO 201 IR=1,12
      DO 201 J=14,28
      A(IR,J-1)=A(IR,J)
201   CONTINUE
      DO 202 IR=14,28
      DO 202 J=1,12
      A(IR-1,J)=A(IR,J)
202   CONTINUE
      DO 203 IR=14,28
      B(IR-1)=B(IR)
      DO 203 J=14,28
      A(IR-1,J-1)=A(IR,J)
203   CONTINUE
      DO 210 IR=1,27
      DO 212 J=1,27
      A1(IR,J)=A(IR,J)
212   CONTINUE
      B1(IR)=B(IR)
210   CONTINUE
      RETURN
      END
$IBFTC MATIENV
      SUBROUTINE MATINV(A,NN,N,B,MM,M)
```

```
C*****************************************************************************
C       THIS SUBROUTINE SOLVES THE SYSTEM OF LINEAR EQATIONS BY GAUSS-JORD
C       AN TECHNIQUE AND EVALUATES THE COEFFICIENTS THE COEFICIENTS WHEN S
C       SUBSTITUTED IN THE ASSUMED CTRVE EQATION FOR DIFFERENT HOURS OF TH
C       E DAY WILL GIVE THE OPTIMUM DISTRIBUTION OF THAT PARTICULAR RANGE
C*****************************************************************************
        DIMENSION A(NN,NN),B(NN,MM),IPIVOT(50),PIVOT(50),INDEX(50,2)
        EQUIVALENCE (IROW,JROW), (ICOLUM,JCOLUM), (AMAX, T, SWAP)
C       INITIALIZATION
   15   DO 20 J=1,N
   20   IPIVOT(J)=0
   30   DO 550 I=1 N
C       SEARCH FOR PIVOT ELEMENT
   40   AMAX=0.0
   45   DO 105 J=1 N
   50   IF (IPIVOT(J)-1) 60, 105, 60
   60   DO 100 K=1,N
   70   IF (IPIVOT(K)-1) 80, 100, 740
   80   IF (ABS (AMAX)-ABS (A(J,K))) 85, 100, 100
   85   IROW=J
   90   ICOLUM=K
   95   AMAX=A(J,K)
  100   CONTINUE
  105   CONTINUE
  110   IPIVOT(ICOLUM)=IPIVOT(ICOLUM)+1
C       INTERCHANGE ROWS TO PUT PIVOT ELEMENT ON DIAGONAL
  130    IF(IROW-ICOLUM) 140,260,140
  140    CONTINUE
  150   DO 200 L=1,N
  160   SWAP=A(IROW,L)
  170   A(IROW,L)=A(ICOLUM,L)
  200   A(ICOLUM,L)=SWAP
  205   IF(M) 260, 260, 210
  210   DO 250 L=1  M
  220   SWAP=B(IROW,L)
  230   B(IROW,L)=B(ICOLUM,L)
  250   B(ICOLUM,L)=SWAP
  260   INDEX(I,1)=IROW
  270   INDEX(I,2)=ICOLUM
  310   PIVOT(I)=A(ICOLUM,ICOLUM)
C       DIVIDE PIVOT ROW BY PIVOT ELEMENT
  330   A(ICOLUM,ICOLUM)=1.0
  340   DO 350 L=1 N
  350   A(ICOLUM,L)=A(ICOLUM,L)/PIVOT(I)
  355   IF(M) 380, 380, 360
  360   DO 370 L=1 M
  370   B(+COLUM,L)=B(ICOLUM,L)/PIVOT(I)
C       REDUCE NON-PIVOT ROWS
```

```
  380 DO 550 L1=1,N
  390 IF(L1-ICOLUM) 400, 550, 400
  400 T=A(L1,ICOLUM)
  420 A(L1,ICOLUM)=0.0
  430 DO 450 L=1 N
  450 A(L1,L)=A(L1,L)-A(ICOLUM,L)*T
  455 IF(M) 550, 550, 460
  460 DO 500 L=1 M
  500 B(L1,L)=B(L1,L)-B(ICOLUM,L)*T
  550 CONTINUE
C       INTERCHANGE COLUMNS
  600 DO 710 I=1 N
  610 L=N+1-I
  620 IF (INDEX(L,1)-INDEX(L,2)) 630, 710, 630
  630 JROW=INDEX(L,1)
  640 JCOLUM=INDEX(L,2)
  650 DO 705 K=1 N
  660 SWAP=A(K,JROW)
  670 A(K,JROW)=A(K,JCOLUM)
  700 A(K,JCOLUM)=SWAP
  705 CONTINUE
  710 CONTINUE
  740 RETURN
        END
$IBFTC SUB1
        SUBROUTINE CONVRT ( DRT, RHH, PR,TN, N )
C*****************************************************************************************
C       THIS SUBROUTINE EVALUATES THE VALUES OF WET BULB TEMPRATURES  FEED
        ING THE VALUES OF DRY BULB TEMPERATURES, RELATIVE HUMIDITY AND PRE
C       SSURE. THE METHOD USED FOR THE SOLUTION OF THIS EQATION IS NEWTON
C       RAPHSON ITERATIONS.
C*****************************************************************************************
        DIMENSION TN(24)
        DIMENSION T(24),RHH(24),DRT(24)
        DBT=DRT(N)
        RH=RHH(N)
        DATA A,B,C,D/16.386396,0.00137804,5696.,459.67/
        DATA E,F,G,+/3.560573,100.,0.2402,0.0000014/
        DATA O,P,Q,R/50.0,0.444,106*.0,32.00/
        DATA S,V,U/0.11,0.62197,1.95/
        SATPR(T)=10.0**(A+B*T-C/(D+T)-E*ALOG((D+T)/F))
      1*(.49119)
        PS=SATPR(DBT)
        PA=PR*0.49119
        PR=PR*0.49119
        PHI=RH/100.
        WPRIME=0.622*PHI*7S/(PA-PS*PHI)
        I=1
```

```
      T(1)=DBT-15.
 20   HGSTAR=P*T(I)+Q
      HWSTAR=T(I)-R+S
      WSSTAR=V*SATPR(T(I))/(PR-SATPR(T(I)))
     1+(U*((T(I)+60.)**5))/(10.**15)
      HGPRI=P
      HWPRI=1.
      IF(T(I)-50.) 100,100,200
 100  CPSTAR=0.2402
      GO TO 300
 200   CPSTAR=0.2402+((0.0000014)*(T(I)-50.))
 300  CONTINUE
      WSSPRI=(V*PR*SATPR(T(I))*ALOG(10.)/((PR-SATPR(T(I)))**2))
     1*(B+C/((D+T(I))**2)-E/(D+T(I)))
     2+(5.*U*((T(I)+60.)**4))/(10.**15)
      W=WSSTAR-(DBT-T(I))*(CPSTAR/(HGSTAR-HWSTAR))
      AF=W-WPRIME
     FPRIME=WSSPRI+(CPSTAR/(HGSTAR-HWSTAR))
     1-(DBT-T(I))
     2*((HGSTAR-HWSTAR)*CPP(T(I))-CPSTAR*(HGPRI-HWPRI))
     3/((HGSTAR-HWSTAR)**2)
      T(I+1)=T(I)-AF/FP9IME
     I=I+1
 23   FORMAT(2X 4(F15.8,2X))
 21   FORMAT(2X 6(F15.8,1X))
 22   FORMAT(2X 4(F15.8,2X))
     IF(ABS(T(I)-T(I-1)).GT.0.001.OR.ABS(W-WPRIME).GT.0.00001) GO TO 20
      TN(N)=T(I)
 700  CONTINUE
 10   FORMAT(3F5.2)
 30   FORMAT(2X 2F15.8)
      RETURN
      END
$IBFTC SUB2
C*****************************************************************************
C     THIS SUBPROGRAM ISUSED TO EVALUATE THE CONSTANT CPP IN THE EVALUAT
C     ION OF WET BULB TEMPERATURE.
C*****************************************************************************
      FUNCTION CPP(T)
      IF(T-50.) 10,10,20
 10   CPP=0.
      RETURN
 20   CPP=0.0000014
      RETURN
      END
$ENTRY
```

4.4 COMPUTER PROGRAM FOR EQUIVALENT TEMPERATURE DIFFENTIAL

```
$IBFTC DILIP
      REAL LAT KRCPW(5),LBYKW(5),KRCPR(5),LBYKR(5)
      COMMON/PI1/PI
     DIMENSION ALPHA(1)
     DATA ALPHA/0.7/
      DIMENSION IT(25)
      PI=4.*ATAN(1.)
      DIMENSION UW(5),UR(5)
      DIMENSION MONTH(6),ALPHAT(2),WALL(5)
      DIMENSION TO(24),WO(5),TEQ(24,5),TSOL(24,5),PHI(5)
      DATA WALL/6H NORTH,6H  WEST,6H SOUTH,6H  EAST,6H  ROOF/
      DATA ALPHAT/6HDARK  ,6HLIGHT /
      DATA MONTH/6H  FEB.,6H APRIL,6H  JUNE,6HAUGUST,6H  OCT.,6H  DEC.
     1 /
      COMMON/SUB/A,B,C,DEC
      DATA PHI/0.,0.,0.,0.,90./
      D+TA WO/0.,90.,180.,270.,0./
     READ901,(UW(I),KRCPW(I),LBYKW(I),I=1,4 )
     READ902,(UR(I),KRCPR(I).LBYKR(I),I=1,3)
      PRINT 117
     READ903,HOW,HOR.HI.
      DO 2.0 IW=1,5
      PHI(IW)=PHI(IW)*PI/180.
  200 WO(IW)=WO(IW)*PI/180.
     READ904,NOCITY
      DO 7000 IC=1,NOCITY
      READ 10,NAM1,NAM2
     READ905,LAT,NDAY
      LAT=LAT*PI/180
      DO 7000 IDAY=1,NDAY
     READ906,NDATE,NDATAP
     MO=NDATE/200
      CALL DECLN(NDATE)
     READ907,(TO(I),I=1,NDATAP)
      DO 7000 IW=1,5
      PHAI=PHI(IW)
      WALANG=WO(IW)
     DO 7000 IALPHA=1,1
      ALPHAW=ALPHA(IALPHA)
      ITOTL=4
       IF(IW.EQ.5)ITOTL=3
      PRINT 110,NAM1,NAM2
      PRINT 118,MONTH(MO)
      PRINT111 WALL(IW'
      PRINT 112,ALPHAT(IALPHA)
  901 FORMAT(12F6.3)
  902 FORMAT(9F6.3)
```

```
  903    FORMAT(3F3.1)
  904   FORMAT(I2)
  905    FORMAT(F4.1,I1)
  906    FORMAT(I4 I2)
  907    FORMAT(16F5.1)
          IF(IW.NE.5)PRINT 113
          IF(IW.EQ.5)PRINT 114
          DO 210 ITYP=1,ITOTL
          IF(IW.NE.5)GO TO 201
          HO=HOR
          U=UR(ITYP)
          ROCPK=KRCPR(ITYP)
          XLBYK=LBYKR(ITYP)
          GO TO 202
   201    HO=HOW
          HO=HOW
          U=UW(ITYP)
          ROCPK=KRCPW(ITYP)
          XLBYK=LBYKW(ITYP)
   202    CALL FURIER(NDATE,LAT,ROCPK,XLBYK,HO,HI,U,WALANG,PHAI,NDATAP,6,
       1  TO,ALPHAW)
          DO 205 ITIM=1,24
          TIME=ITIM
          IT(ITIM)=ITIM
          CALL CALCUL(TIME,TEQL,TSAL,6)
          TEQ(ITIM ITYP)=TEQL
  205     TSOL(ITIM,ITYP)=TSAL
  210     CONTINUE
        DO 211 I=1 24
          IF(IW.NE.5)GO TO 300
          PRINT 116,IT(I),(TSOL(I,J),TEQ(I,J),J=1,ITOTL)
          GO TO 211
  300     PRINT 115,IT(I),(TSOL(I,J),TEQ(I,J),J=1,ITOTL)
  211     CONTINUE
 7000     CONTINUE
   10     FORMAT(2A6)
  110   FORMAT(//50X,20(1H*)/50X,1H*,2A6,2X,*CITY*,1H*/50X,20(1H*))
  111     FORMAT(/  55X,A6,*  WALL*)
  112     FORMAT(/55X,A6,*COLORED*)
  113     FORMAT(/    12X,10X,*TYPE 1*,20X,*TYPE 2*,20X,*TYPE 3*,20X,
      1        *TYPE 4*/3X,* HRS.       *,4(*   T SOL AIR       T EQVT.    *))
  114     FORMAT(/    12X,10X,*TYPE 1*,20X,*TYPE 2*,20X,*TYPE 3*/
      1                 3X,* HRS.       *,3(*   T SOL AIR       T EQVT.    *))
  116     FORMAT(4X,I2,*.00*,1X,3(3X,F6.1,4X,3X,F6.1,4X))
  115     FORMAT(4X,I2,*.00*,1X,4(3X,F6.1,4X,3X,F6.1,4X))
  117     FORMAT(1H1)
  118     FORMAT(//55X,*15TH*,2X,A6/)
          STOP
          END
$IBFTC FURIER
```

```
      SUBROUTINE FURIER(NDE,LAT,KROCP,LBYK,HO,HI,U,WO,PHI,NDATA,NHARM,TO
     1 ,ALPHAW)
C     THIS SUBROUTINE CALCULATES THE COEFFICIENTS OF THE FOURIER SERIES
C     OF TEQ AND TSOL.
      COMMON/PI1/PI
      COMMON/SUB/A,B,C,DEC
      COMMON TM(10),TN(10),TEM,TEQ(10),SI(10),PHEE(10),XLAMDA(10)
      DIMENSION TO(NDATA)
      REAL ID,IDH,IDN,LAT,KROCP,LBYK
      DO 50 L=1,NHARM
      TM(L)=0.
   50 TN(L)=0.
      HSUN=ARCOS(-TAN(LAT)*TAN(DEC))
      IDN(BETA)=A/EXP(B/SIN(BETA))
      TEM=..
      DO 100 I=1,NDATA
      X=I
      H=ABS(12.-X)*PI/12.
      BETA=ARSIN(COS(LAT)*COS(DEC)*COS(H)+SIN(LAT)*SIN(DEC))
      COGAMA=(COS(LAT)*SIN(DEC)-COS(DEC)*SIN(LAT)*COS(H))/COS(BETA)
      GAMA=ARCOS(COGAMA)
      IF(I.GT.12) ALPHA=ABS(WO-GAMA)
      IF(I.LE.12)ALPHA=ABS(2.*PI-WO-GAMA)
      THETA=ARCOS(COS(BETA)*COS(ALPHA)*COS(PHI)+SIN(BETA)*SIN(PHI))
      IF(PHI.EQ.PI/2.)THETA=PI/2.-BETA
      ID=IDN(BETA)*COS(THETA)
      IDH=C*IDN(BETA)
      IF(ID.LT.0.)ID=0
      DATA RHO/0.3/
      REAL IH,ITOTAL
      IH=IDN(BETA)*SIN(BETA)+IDH
      IF(PHI.EQ.PI/2.)IH=0.
     IF(PHI GT.PI/4.)ITOTAL=ID+IDH+RHO*IH/2.
     IF(PHI.LE.PI/4.)ITOTAL=ID+CONST(THETA)*IDH+RHO*IH/2.
      IF(H GT.HSUN)ITOTAL=..
      IF(ITOTAL.LT.0.)ITOTAL=0.
      TE=ITOTAL*ALPHAW/HO+TO(I)
      TEM=TEM+(1./24.)*TE
      X=X*PI/12.
      DO 60 J=1,NHARM
      Z=J
      Z=Z*X
      TM(J)=TM(J)+TE*COS(Z)/12.
   60 TN(J)=TN(J)+TE*SIN(Z)/12.
  10.  CONTINUE
      DO 110 I=1,NHARM
      SAT=ATAN(ABS(TN(I)/TM(I)))
      X=I
      WI=PI*X/12.
      TEQ(I)=SQRT(TM(I)**2+TN(I)**2)
```

```
      IF((TN(I).GE.0.).AND.(TM(I).GE.0.))SI(I)=SAI
      IF((TN(I).GT.0.).AND.(TM(I).LT.0.))SI(I)=PI-SAI
      IF((TN(I).LT.0.).AND.(TM(I).GT.0.))SI(I)=-SAI
      IF((TN(I).LT.0.).AND.(TM(I).LT.0.))SI(I)=PI+SAI
      COF1=HO*HI/(WI*KROCP)
      COF2=(HO+HI)/SQRT(WI*KROCP/2.)
      ANG=SQRT(WI*KROCP/2.)*LBYK
      YI=(COF1+1.)*COS(ANG)*SINH(ANG)+(COF1-1.)*SIN(ANG)*COSH(ANG)
     1 +COF2*COS(ANG)*COSH(ANG)
      ZI=(COF1+1.)*SIN(ANG)*COSH(ANG)+(1.-COF1)*COS(ANG)*SINH(ANG)
     1 +COF2*SIN(ANG)*S9NH(ANG)
      VI=HO*HI/(SQRT(W9*KROCP/2.)*SQRT(YI*YI+ZI*ZI))
      PHAI=ATAN(ABS(ZI/YI))
      IF((ZI.GE.0.).AND.(YI.GE.0.))PHEE(I)=PHAI
      IF((ZI.LT.0.).AND.(YI.LT.0.))PHEE(I)=PI+PHAI
      IF((ZI.LT.0.).AND.(YI.GT.0.))PHEE(I)=-PHAI
      IF((ZI.GT.0.).AND.(YI.LT.0.))PHEE(I)=PI-PHAI
  110 XLAMDA(I)=VI/U
      RETURN
      END
$IBFTC CALCUL
      SUBROUTINE CALCUL(TIME,TEQL,TSOL,NHARM)
C     THIS SUBROUTINE CALCULATES THE SOL AIR TEMP. AND THE EQVLT. TEMP.,
C       ONCE THE COFFFIC9ENTS OF THE HARMONIC SERIES HAVE BEEN COMPUTED
C       BY SUBROUTINE FURIER.
      COMMON/PI1/PI
      COMMON TM(10),TN(10),TEM,TEQ(10),SI(10),PHEE(10),XLAMDA(10)
      TEQL=TEM
      TSOL=TEM
      DO 1900 NL=1,NHARM
      XNL=NL
      XNL=XNL*TIME*PI/12.
      TSOL=TSOL+TEQ(NL)*COS(XNL-SI(NL))
 1900 TEQL=TEQL+XLAMDA(NL)*TEQ(NL)*COS(XNL-SI(NL)-PHEE(NL))
      RETURN
      END
$IBFTC CONST
      FUNCTION CONST(THETA)
      X=COS(THETA)
      IF(X.GT.(-0.2)) GO TO 10
      CONST=0.44
      RETURN
   10 CONST=.56+.437*X+.313*X*X
      RETURN
      END
$IBFTC DECLN
      SUBROUTINE DECLN(NDAY)
      COMMON/PI1/PI
      COMMON/SUB/A,B,C,DEC
      DIMENSION D(12,4),E(12),F(12),G(12)
```

```
      DATA E/370.,385.,376.,360.,350.,345.,344.,351.,365.,378.,387.,
     1 391./
      DATA F/.142,.144,.156,.18,.196,.205,.207,.201,.177,.160,.149,
     1 .142/
      DATA G/.058,.060,.071,.097,.121,.134,.136,.122,.092,.073,.063,
     1 .057/
      DATA D(1,1),D(1,2),D(1,3),D(1,4)/-23.1333,-22.33,-21.25,-19.833/
      DATA D(2,1),D(2,2),D(2,3),D(2,4)/-17.3,-15.217,-12.917,-10.45 /
      DATA D(3,1),D(3,2),D(3,3),D(3,4)/-7.85,-5.167,-2.417,0.35   /
      DATA D(4,1),D(4,2),D(4,3),D(4,4)/4.267,6.933,9.25,11.95    /
      DATA D(5,1),D(5,2),D(5,3),D(5,4)/14.85,16.883,18.685,20.233/
      DATA D(6,1),D(6,2),D(6,3),D(6,4)/21.95,22.783,23.283,23.45 /
      DATA D(7,1),D(7,2),D(7,3),D(7,4)/23.167,22.567,21.65,20.4167/
      DATA D(8,1),D(8,2),D(8,3),D(8,4)/18.2,16.35,14.8333,12.033 /
      DATA D(9,1),D(9,2),D(9,3),D(9,4)/3.05,5.967,3.316,0.6/
      DATA D(10,1),D(10,2),D(10,3),D(10,4)/-2.9,-5.6,-8.25,-10.8/
      DATA D(11,1),D(11,2),D(11,3),D(11,4)/-14.2,-16.367,-18.3,-19.983
     1 /
      DATA D(12,1),D(12,2),D(12,3),D(12,4)/-21.6833,-22.6333,-23.233,
     1 -23.45/
      I=NDAY/100
      J1=NDAY-100*I
      J=J1/7+1
      XJ=J1-(7*(J-1)+1)
      IF(J.NE.4)GO TO 10
      I1=I+1
      IF(I.EQ.12)I1=1
      DNEXT=D(I1,1)
      GO TO 15
   10 DNEXT=D(I,J+1)
   15 DEC=D(I,J)+XJ*(DNEXT-D(I,J))/7.
      A=E(I)
      B=F(I)
      C=G(I)
      DEC=DEC*ATAN(1.)*4./180.
      RETURN
      END
$ENTRY
```

4.5 COMPUTER PROGRAM FOR SOLAR HEAT GAINS

```
$IBFTC MAIN
      DIMENSION MO(12)
      COMMON/SUB/A,B,C,DEC
         DATA MO/6H  JAN.,6H  FEB.,6HMARCH.,6HAPRIL ,6H   MAY,6H  JUNE
     1,6H  JULY,6HAUGUST,6H  SEPT,6H  OCT.,6H  NOV.,6H  DEC./
      PI=4.*ATAN(1.)
      REAL LAT
        REAL IDIR(25),IDIF(25),IREF(25),IH,IN,ID,IDH,IDN,AL(2)
      DO 888 ITAP=1,11
 710  READ,LAT,NDATE
      IF(LAT.EQ.90.) GO TO 820
 712  FORMAT(F4.1,FI4)
      DN(BETA)=A/EXP(B/SIN(BETA))
      CALL DECLN(NDATE)
      LAT=LAT*PI/180.
      HSUN=ARCOS(-TAN(LAT)*TAN(DEC))
      HS=HSUN*180./PI
      PRINT 201,HS
      MON=NDATE/100
      IDA=NDATE-MON*100
      PRINT 701 LAT,MO(MON),IDA
 701  FORMAT(2X,*LATITUDE*,F7.3,5X,A6,5X,*DATE*,I2)
      PRINT 702
 702  FORMAT(1H0)
      DO 700 IW=1,9
      PHI=0.
      IF(IW.EQ.9) PHI=PI/2.
      XW=IW
      WO=(XW-1.)*PI/4.
      WAN=WO*180./PI
      PRINT 202,WAN
      PRINT 705
 705  FORMAT(1H0)
      DO 10. I=6 18
      X=I
      H=ABS(X-12.)*PI/12.
      D=ARSIN(COS(LAT)*COS(DEC)*COS(H)+SIN(LAT)*SIN(DEC))
      CG='COS(LAT)MSI5(D5C'-C6S(DEC'*SI5(LAT)*COS(H))/COS(D)
      G=ARCOS(CG)
      IF(I.LE.12)ALPHA=ABS(2.*PI-WO-G)
      IF(I.GT.12)ALPHA=ABS(WO-G)
      T=ARCOS(COS(D)*COS(ALPHA)*COS(PHI)+SIN(D)*SIN(PHI))
      ID=DN(D)
      IF(H.GT.HSUN)ID=0
      IF(ID.LT.0.)ID=0
      IDH=C*ID
      IDIR(I)=ID*COS(T)
```

```
        IF(IDIR(I).LT.0.)IDIR(I)=0.
      IDIF(I)=IDH
      IF(PHI.LE.PI/4.)IDIF(I)=CONST(T)*IDH
      IH=ID*SIN(D)+IDH
      IREF(I)=.15*IH
      DELTA=ATAN(TAN(D)/COS(ALPHA))
      TAND=TAN(DELTA)
      TANA=TAN(ALP+A)
      TANAD=TANA*TAND
      DELTA=DELTA*180./PI
        IF(COS(T).GT.0.)GO TO 99
      TD=0.
        XD=0.
      AB=0.
      TAU=0.
      RF=0.
      ALP=0.
      GO TO 1000
   99 TD=ARSIN(SIN(T)/1.526)
      XD=(1./8.)/COS(TD)
      AB=EXP(-.174*XD)
      RF=0.5*((SIN(T-TD)/SIN(T+TD))**2+(TAN(T-TD)/TAN(T+TD))**2)
      TAU=(1.-RF)*M2*AB/(1.-RF*RF*AB*AB)
      ALP=1.-RF-(1.-RF)**2*AB/(1.-RF*AB)
 1000 D=D*180./PI
      G=G*180./PI
      ALPHA=ALPHA*180./PI
      T=T*180./PI
  100 PRINT 200,I,IDIR(I),IDIF(I),IREF(I),D,G,ALPHA,T,TAU,ALP,DELTA,
     1TANA,TAND,TANAD
  700 CONTINUE
       GO TO 710
  820  CONTINUE
  200  FORMAT(1X,I3,9F10.3,4F9.4)
  201  FORMAT(10X *HOUR ANGLE AT SUNRISE*,F10.2,* DEGREES*)
  202  FORMAT(*  WALL ANGLE MEASURED FROM NORTH*,F10.2,*DEGREES*)
  888  CONTINUE
       STOP
       END
       FUNCTION CONST(T)
       X=COS(T)
       A=-.2
       IF(X.GT.A)GO TO 10
       CONST=.44
       RETURN
   10  CONST=.56+.437*X+.313*X*X
       RETURN
       END
$IBFTC DECLN
         SUBROUTINE DECLN(NDAY)
```

```
      COMMON/PI1/PI
      COMMON/SUB/A,B,C,DEC
      DIMENSION D(12,4),E(12),F(12),G(12)
      DATA E/390.,385.,376.,360.,350.,348.,344.,351.,365.,378.,387.,
     1 391./
      DATA F/.142,.144,.156,.18,.196,.205,.207,.201,.177,.160,.149,
     1 .142/
      DATA G/.058,.060,.071,.097,.121,.134,.136,.122,.092,.073,.063,
     1 .057/
      DATA D(1,1),D(1,2),D(1,3),D(1,4)/-23.1333,-22.33,-21.25,-19.833/
      DATA D(2,1),D(2,2),D(2,3),D(2,4)/-17.3,-15C217,-12.917,-10.45 /
      DATA D(3,1),D(3,2),D(3,3),D(3,4)/-7.85,-5.167,-2.417,0.35    /
      DATA D(4,1),D(4,2),D(4,3),D(4,4)/4.267,6.933,9.25,11.95     /
      DATA D(5,1),D(5,2),D(5,3),D(5,4)/14.85,16.883,18.085,20.233/
      DATA D(6,1),D(6,2),D(6,3),D(6,4)/21.95,22.783,23.283,23.45 /
      DATA D(7,1),D(7,2),D(7,3),D(7,4)/23.167,22.567,21.65,20.4167/
      DATA D(8,1),D(8,2),D(8,3),D(8,4)/18.2,16.35,14.8333,12.033 /
      DATA D(9,1),D(9,2),D(9,3),D(9,4)/3.55,5.967,3.316,0.6/
      DATA D(10,1),D(10,2),D(10,3),D(10,4)/-2.9,-5.6,-8.25,-10.8/
      DATA D(11,1),D(11,2),D(11,3),D(11,4)/-14.2,-16.367,-18.3,-19.983
     1 /
      DATA D(12,1),D(12,2),D(12,3),D(12,4)/-21.6833,-22.6333,-23.233,
     1 -23.45/
      I=NDAY/100
      J1=NDAY-100*I
      J=J1/7+1
      XJ=J1-(7*(J-1)+1)
      IF(J.NE.4)GO TO 10
      I1=I+1
      IF(I.EQ.12)I1=1
      DNEXT=D(I1,1)
      GO TO 15
   10 DNEXT=D(I,J+1)
   15 DEC=D(I,J)+XJ*(DNEXT-D(I,J))/7.
      A=E(I)
      B=F(I)
      C=G(I)
      DEC=DEC*ATAN(1.)*4./180.
      RETURN
      END
$ENTRY
```

CHAPTER 5

RESULTS

In this chapter results of various computer programmes are presented. A geographical map in India is also presented for convenience and for extrapolating design conditions for adjoining cities.

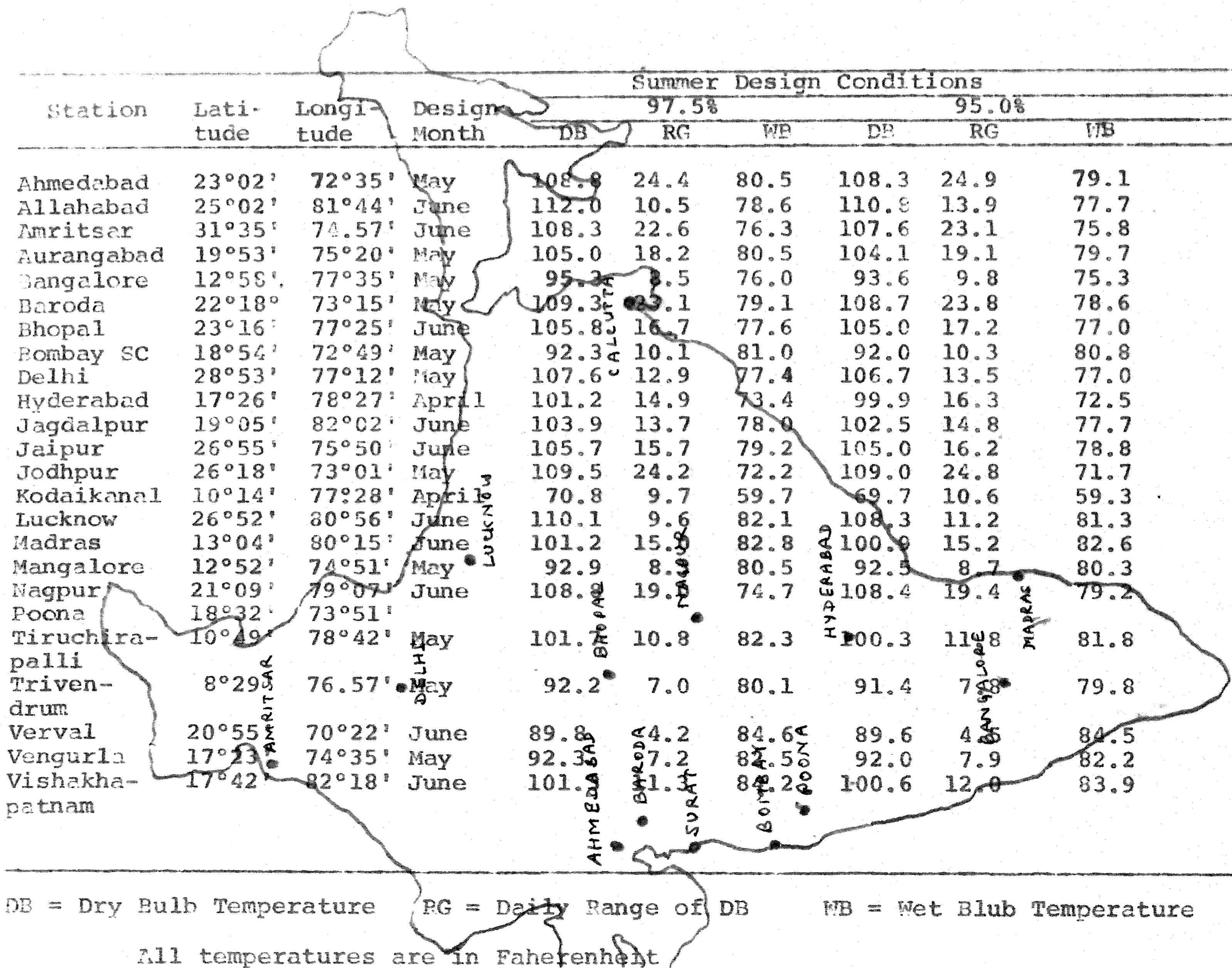
Section 5.1 presents physical data and the computed summer and monsoon outdoor design conditions for 25 stations in India. These can be used by airconditioning engineer in assessment of cooling loads. The values for various confidence limits represent the conditions that shall not be exceeded 99.5, 99, 97.5 and 95 percent of the hours of summer and monsoon months.

Section 5.2 contains the results of average hourly dry and wet bulb temperature distribution for various specified daily range of these temperatures. These are to be used in hourly computation of cooling load for a given city, range having been obtained from tables in Section 5.1, in order to arrive at the peak load and the time of its occurence. This is specially important for airconditioning systems operated on an intermittent basis, that is less than 24 hours everyday, as is the case for most office buildings and public spaces.

Computed values of equivalent temperature differential for various wall and roof constructions have been presented in Section 5.3, for Ahmedabad, Allahabad, Amritsar, Delhi, Bombay and Madras, both for summer and monsoon months. These

are to be used by the airconditioning engineer in calculating the unsteady state heat gain through walls and roof of the building. Heat transmission through windows and other glazed surfaces can be estimated by results presented in Section 5.4 for the same six cities. These cities have been selected to represent the various Indian latitudes and extrapolation can be made for other cities.

DESIGN OUTDOOR CONDITIONS FOR INDIA



Station	Latitude	Longitude	Design Month	Summer Design Conditions 97.5% DB	97.5% RG	97.5% WB	95.0% DB	95.0% RG	95.0% WB
Ahmedabad	23°02'	72°35'	May	108.8	24.4	80.5	108.3	24.9	79.1
Allahabad	25°02'	81°44'	June	112.0	10.5	78.6	110.8	13.9	77.7
Amritsar	31°35'	74.57'	June	108.3	22.6	76.3	107.6	23.1	75.8
Aurangabad	19°53'	75°20'	May	105.0	18.2	80.5	104.1	19.1	79.7
Bangalore	12°58'	77°35'	May	95.3	8.5	76.0	93.6	9.8	75.3
Baroda	22°18'	73°15'	May	109.3	23.1	79.1	108.7	23.8	78.6
Bhopal	23°16'	77°25'	June	105.8	16.7	77.6	105.0	17.2	77.0
Bombay SC	18°54'	72°49'	May	92.3	10.1	81.0	92.0	10.3	80.8
Delhi	28°53'	77°12'	May	107.6	12.9	77.4	106.7	13.5	77.0
Hyderabad	17°26'	78°27'	April	101.2	14.9	73.4	99.9	16.3	72.5
Jagdalpur	19°05'	82°02'	June	103.9	13.7	78.0	102.5	14.8	77.7
Jaipur	26°55'	75°50'	June	105.7	15.7	79.2	105.0	16.2	78.8
Jodhpur	26°18'	73°01'	May	109.5	24.2	72.2	109.0	24.8	71.7
Kodaikanal	10°14'	77°28'	April	70.8	9.7	59.7	69.7	10.6	59.3
Lucknow	26°52'	80°56'	June	110.1	9.6	82.1	108.3	11.2	81.3
Madras	13°04'	80°15'	June	101.2	15.0	82.8	100.9	15.2	82.6
Mangalore	12°52'	74°51'	May	92.9	8.[illegible]	80.5	92.5	8.7	80.3
Nagpur	21°09'	79°07'	June	108.8	19.[illegible]	74.7	108.4	19.4	79.2
Poona	18°32'	73°51'							
Tiruchirapalli	10°49'	78°42'	May	101.[illegible]	10.8	82.3	100.3	11.8	81.8
Trivendrum	8°29'	76.57'	May	92.2	7.0	80.1	91.4	7.8	79.8
Verval	20°55'	70°22'	June	89.8	4.2	84.6	89.6	4.[illegible]	84.5
Vengurla	17°23'	74°35'	May	92.3	7.2	8[illegible].5	92.0	7.9	82.2
Vishakhapatnam	17°42'	82°18'	June	101.[illegible]	[illegible]1.3	8[illegible].2	100.6	12.0	83.9

DB = Dry Bulb Temperature RG = Daily Range of DB WB = Wet Blub Temperature

All temperatures are in Fahetenheit

FIG. 5.

Section 5.1: Design conditions for various cities in India

DESIGN OUTDOOR CONDITIONS FOR INDIA

Station	Latitude	Longitude	Design Month	Summer Design Conditions 97.5% DB	97.5% RG	97.5% WB	95.0% DB	95.0% RG	95.0% WB
Ahmedabad	23°02'	72°35'	May	108.8	24.4	80.5	108.3	24.9	79.1
Allahabad	25°02'	81°44'	June	112.0	10.5	78.6	110.8	13.9	77.7
Amritsar	31°35'	74.57'	June	108.3	22.6	76.3	107.6	23.1	75.8
Aurangabad	19°53'	75°20'	May	105.0	18.2	80.5	104.1	19.1	79.7
Bangalore	12°58'.	77°35'	May	95.3	8.5	76.0	93.6	9.8	75.3
Baroda	22°18°	73°15'	May	109.3	23.1	79.1	108.7	23.8	78.6
Bhopal	23°16'	77°25'	June	105.8	16.7	77.6	105.0	17.2	77.0
Bombay SC	18°54'	72°49'	May	92.3	10.1	81.0	92.0	10.3	80.8
Delhi	28°53'	77°12'	May	107.6	12.9	77.4	106.7	13.5	77.0
Hyderabad	17°26'	78°27'	April	101.2	14.9	73.4	99.9	16.3	72.5
Jagdalpur	19°05'	82°02'	June	103.9	13.7	78.0	102.5	14.8	77.7
Jaipur	26°55'	75°50'	June	105.7	15.7	79.2	105.0	16.2	78.8
Jodhpur	26°18'	73°01'	May	109.5	24.2	72.2	109.0	24.8	71.7
Kodaikanal	10°14'	77°28'	April	70.8	9.7	59.7	69.7	10.6	59.3
Lucknow	26°52'	80°56'	June	110.1	9.6	82.1	108.3	11.2	81.3
Madras	13°04'	80°15'	June	101.2	15.0	82.8	100.9	15.2	82.6
Mangalore	12°52'	74°51'	May	92.9	8.3	80.5	92.5	8.7	80.3
Nagpur	21°09'	79°07'	June	108.8	19.0	74.7	108.4	19.4	79.2
Poona	18°32'	73°51'							
Tiruchirapalli	10°49'	78°42'	May	101.7	10.8	82.3	100.3	11.8	81.8
Trivendrum	8°29'	76.57'	May	92.2	7.0	80.1	91.4	7.8	79.8
Verval	20°55'	70°22'	June	89.8	4.2	84.6	89.6	4.5	84.5
Vengurla	17°23'	74°35'	May	92.3	7.2	82.5	92.0	7.9	82.2
Vishakhapatnam	17°42'	82°18'	June	101.3	11.3	84.2	100.6	12.0	83.9

DB = Dry Bulb Temperature RG = Daily Range of DB WB = Wet Blub Temperature

DESIGN OUTDOOR CONDITIONS FOR INDIA

Station	Latitude	Longitude	Design Month	Summer Design Conditions 99.5% DB	99.5% RG	99.5% WB	99.0% DB	99.0% RG	99.0% WB
Ahmedabad	23°02'	72°35'	May	110.0	22.8	109.4	23.5	82.5	108.8
Allahabad	25°2'	81°44'	June	114.9	9.2	80.9	113.7	10.7	79.9
Amritsar	31°35'	74°57'	June	110.1	21.4	77.5	109.3	21.9	77.0
Aurangabad	19°53'	75°20'	May	107.4	16.1	82.5	106.3	17.1	81.6
Bangalore	12°58'	77°35'	May	100.0	5.0	77.8	97.9	6.6	76.9
Baroda	22°18'	73°15'	May	110.8	21.4	80.5	110.1	22.1	79.9
Bhopal	23°16'	77°25'	June	107.8	15.5	79.1	106.9	16.0	78.5
Bombay SC	18°54'	72°49'	May	93.1	9.6	81.6	92.8	9.8	81.3
Delhi	28°53'	77°12'	May	109.6	11.4	78.2	108.7	12.1	77.9
Hyderabad	17°26'	78°27'	April	104.5	11.3	76.0	103.0	12.9	74.8
Jagdalpur	19°05'	82°02'	June	107.5	11.0	78.9	105.9	12.2	78.5
Jaipur	26°55'	75°50'	June	107.2	14.7	80.2	106.6	15.1	79.7
Jodhpur	27°18'	73°01'	May	110.5	22.8	73.5	110.1	23.5	73.0
Kodaikanal	10°14'	77°28'	April	73.8	7.4	60.8	72.4	8.5	60.3
Lucknow	26°52'	80°56'	June	114.9	5.5	84.1	112.7	7.4	83.2
Madras	13°05'	80°15'	**June**	102.1	14.3	83.5	101.7	14.6	83.2
Mangalore	12°52'	74°**51'**	May	94.0	7.3	80.9	93.5	7.9	80.7
Nagpur	21°09'	79°07'	June	109.7	18.0	75.9	109.3	18.5	75.9
Poona	18°32'	73°51'							
Tiruchirapalli	10°49'	78°42'	May	105.2	8.1	83.6	103.6	9.3	83.0
Trivendrum	8°29'	76°57'	May	94.6	5.1	80.9	93.5	6.0	80.6
Verval	20°55'	70°22'	June	90.3	3.4	85.1	90.1	3.7	84.9
Vengurla	17°23'	74°35'	May	92.8	5.5	83.2	92.6	6.3	82.9
Vishakhapatnam	17°42'	82°18'	June	103.2	9.7	85.2	102.4	10.4	84.7

DB = Dry **Bulb temperature** RG = Daily Range of DB WB = Wet **Bulb** temperature

All the temperatures are in Fahrenheit

DESIGN OUTDOOR CONDITIONS FOR INDIA

Station	Latitude	Longitude	Design Month	Monsoon Design Conditions 99.5%			99.0%		
				DB	RG	WB	DB	RG	WB
Ahmedabad	23°02'	72°35'	July	92.7	4.7	82.1	92.0	5.5	81.6
Allahabad	25°27'	81°44'	August	92.7	7.2	86.1	92.4	7.6	85.7
Amritsar	31°35'	74°57'	August	94.5	9.1	86.0	94.1	9.5	85.6
Aurangabad	19°53'	75°20'	July	89.1	9.6	78.0	88.6	10.1	77.5
Bangalore	12°58'	77°35'	August	82.6	7.8	73.8	82.0	8.3	73.3
Baroda	22°18'	73°15'	August	93.4	8.1	83.6	92.9	8.5	83.3
Bhopal	23°16'	77°25'	August	85.7	3.3	78.7	85.1	3.9	78.3
Bombay SC	18°54'	72°49'	August	86.1	3.0	80.9	85.7	3.3	80.6
Delhi	28°53'	77°12'	August	97.6	3.4	83.7	96.8	3.7	83.4
Hyderabad	17°26'	78°27'	August	84.6	5.6	77.6	83.9	5.9	77.1
Jagdalpur	19°05	82°02'	August	86.4	6.1	81.1	85.7	6.6	80.1
Jaipur	26°55'	75°50'	Septem.	92.4	4.3	82.8	91.7	4.9	82.4
Jodhpur	26°18'	73°01'	August	96.5	7.3	80.8	75.6	7.9	80.4
Kodaikanal	10°14'	77°28'	Septem.	64.6	5.4	61.9	64.4	6.1	61.1
Lucknow	26°52'	80°56'	August	95.4	6.2	85.9	94.6	7.1	85.3
Madras	13°04'	80°15'	Septem.	92.5	7.6	82.6	92.0	8.1	82.4
Mangalore	12°52'	74°51'	August	83.5	3.0	78.3	83.0	3.3	78.1
Nagpur	21°09'	79°07'	August	89.9	2.9	81.9	88.9	3.8	81.2
Poona	18°32'	73°51'							
Tiruchirapalli	10°49'	78°42'	Septem.	96.2	10.6	79.3	95.5	11.3	78.8
Trivendrum	8°29'	76°57'	August	84.4	5.5	79.3	84.1	5.9	78.9
Verval	20°55'	70°22'	August	87.2	0.6	83.1	86.1	1.0	82.7
Vengurla	17°23'	74°35'	July	85.9	4.3	80.6	85.0	4.5	80.4
Vishakhapatnam	17°42'	82°18'	August	90.0	6.5	81.7	89.7	6.8	81.5

DB = Dry Bulb Temperature RG = Daily Range of DB WB = Wet Bulb Temperature

All the temperatures are in Fahrenheit

CORRECTIONS IN OUTDOOR DESIGN WET BULB TEMPERATURES FOR TIME OF DAY (FOR COOLING LOAD ESTIMATES).

Time	DAILY RANGES IN °F						
	5	7	10	12	15	20	22
1 AM	3.06	3.90	5.94	6.40	11.20	13.70	14.90
2	3.24	4.10	6.46	7.60	11.80	14.01	15.70
3	3.78	4.40	7.56	8.20	12.60	16.20	16.80
4	3.96	4.90	8.82	8.70	13.40	17.60	17.90
5.	4.14	5.40	9.54	9.20	14.20	18.20	18.80
6	4.50	6.00	10.00	10.80	14.60	19.30	19.70
7	4.90	6.50	9.50	12.00	15.00	19.60	20.32
8	5.00	7.00	8.20	11.30	14.40	20.00	22.00
9	3.24	6.30	5.76	9.60	11.60	19.00	20.70
10	2.70	4.60	2.70	6.40	9.00	15.00	16.20
11	1.80	3.20	1.80	4.20	6.80	11.60	14.10
12	0.90	1.60	1.26	3.10	4.40	9.00	12.10
13 PM	0.18	0.90	0.72	2.60	3.20	6.00	9.60
2	0.00	0.60	0.36	1.50	1.60	2.80	6.10
3	0.00	0.00	0.00	0.90	0.00	1.60	4.00
4	0.00	0.00	0.00	0.60	0.20	0.00	2.80
5	0.00	0.00	0.00	0.00	1.40	0.60	0.00
6	0.00	0.40	0.54	0.30	3.80	2.40	1.90
7	0.18	0.90	1.26	0.90	5.80	2.80	3.20
8	0.36	1.20	3.24	1.80	6.60	6.20	6.10
9	0.72	1.60	3.94	2.80	7.22	9.40	8.90
10	1.26	2.10	4.86	3.90	8.20	11.40	11.70
11	1.98	2.60	4.22	4.80	9.00	12.40	13.10
12	2.52	3.10	4.80	5.90	10.00	12.60	14.20

CORRECTIONS IN OUTDOOR DESIGN DRY BULB TEMPERATURES FOR TIME OF DAY (FOR COOLING LOAD ESTIMATES).

Time	DAILY RANGES IN °F.						
	5	10	15	20	25	30	35
1 AM	1.73	3.01	3.49	4.49	6.48	5.41	5.68
2	1.70	2.69	3.06	3.71	5.57	4.00	3.75
3	1.57	2.41	2.60	3.03	4.79	3.27	3.12
4	1.28	2000	2.20	1.80	3.84	2.95	2.44
5	1.01	1.41	1.67	1.22	2.57	2.52	1.77
6	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7	0.90	2.31	1.40	1.41	0.89	2.63	3.79
8	1.43	2.62	2.76	4.30	6.87	7.31	12.97
9	2.70	3.83	5.14	9.07	12.25	15.54	21.43
10	3.15	5.20	6.48	11.65	15.52	20.85	26.56
11	3.26	6.43	8.74	14.07	19.52	23.92	30.34
12	3.54	7.05	11.28	16.56	21.68	26.78	32.28
1 PM	3.89	7.11	12.14	17.60	23.43	28.41	34.17
2	3.73	8.05	13.39	17.90	24.28	29.56	34.62
3	5.00	10.00	15.00	20.00	25.00	30.00	35.00
4	3.59	8.15	13.28	17.47	24.82	29.27	33.99
5	3.33	7.23	12.80	17.20	24.46	28.15	33.58
6	3.17	5.65	12.00	16.06	22.45	26.10	28.63
7	2.60	4.57	10.91	12.89	18.83	21.37	24.04
8	2.22	3.73	9.24	10.71	15.37	16.55	19.32
9	1.59	2.53	7.99	8.97	13.10	14.02	16.75
10	1.55	2.17	6.12	7.56	11.58	12.42	15.63
11	1.54	1.84	6.12	6.60	10.52	10.55	14.46
12	1.18	1.43	5.43	5.68	8.53	9.45	11.35

EQUIVALENT TEMPERATURE DIFFERENCE FOR MEDIUM COLOURED (α=0.7) WALLS AND ROOFS IN AMHEDABAD

Based on 110^{o}F Outdoor Design Temp; Constant 75^{o}F db Room Temperature; 23^{o}F Daily Range; May and $23^{o}0'$ N Lat.

Exposure	Type of Wall	SUN TIME								
		AM			PM					
		8	10	12	2	4	6	8	10	12
North	1	20	24	24	25	26	26	19	15	14
	2	18	17	18	19	20	20	21	21	20
	3	16	17	19	20	21	22	22	21	20
	4	16	16	18	19	21	22	23	22	21
Northwest	1	14	19	22	28	39	40	23	15	14
	2	19	19	19	19	20	22	24	25	24
	3	17	17	18	19	21	25	28	26	24
	4	17	16	17	18	20	24	28	28	24
West	1	14	19	22	30	43	43	24	15	14
	2	20	19	19	19	20	22	25	26	25
	3	18	17	18	19	22	26	29	28	25
	4	17	16	17	18	20	25	30	30	27
Southwest	1	15	19	22	28	36	33	20	15	14
	2	18	18	18	18	19	21	23	23	22
	3	17	17	17	19	21	24	26	24	22
	4	16	16	16	18	20	24	26	26	23
South	1	15	20	24	25	24	20	16	14	14
	2	17	16	17	17	18	19	19	19	19
	3	15	16	17	18	20	20	20	19	18
	4	15	15	16	18	19	21	21	20	19
Southeast	1	23	33	32	26	24	20	16	14	14
	2	18	18	19	21	22	22	22	22	21
	3	16	18	21	24	24	24	23	21	19
	4	15	17	20	23	25	25	24	22	20
East	1	31	43	36	26	24	20	16	14	13
	2	19	19	22	24	25	25	24	23	22
	3	17	20	25	27	27	26	24	22	20
	4	16	18	24	28	28	27	26	23	21
Northeast	1	30	39	33	26	24	20	16	14	14
	22	18	19	21	23	24	24	23	23	21
	3	17	21	24	26	25	25	23	22	20
	4	16	18	23	26	26	26	25	23	21
Roof	1	39	64	76	73	57	29	16	16	16
	2	17	20	31	44	55	59	54	45	36
	3	17	32	52	66	69	60	42	29	21

EQUIVALENT TEMPERATURE DIFFERENCE FOR MEDIUM COLOURED (α=0.7) WALLS AND ROOFS IN AHMEDABAD

Based on 93^{o}F Outdoor Design Temp; Constant 75^{o}F db Room Temperature; 5^{o}F Daily Range; July and 23^{o}0' N Lat.

Exposure	Type of Wall	SUN TIME AM 8	10	12	PM 2	4	6	8	10	12
North	1	16	24	32	38	40	40	31	23	20
	2	24	23	23	23	25	27	29	29	29
	3	21	20	22	24	27	30	32	31	29
	4	20	19	20	23	26	30	33	33	31
Northwest	1	14	23	31	41	52	55	35	24	19
	2	26	24	24	24	26	29	32	34	33
	3	22	21	22	24	28	34	38	37	33
	4	22	20	20	22	26	32	48	39	36
West	1	14	23	31	44	60	60	36	22	19
	2	27	25	25	25	27	30	34	36	35
	3	23	21	22	25	29	36	40	39	35
	4	22	20	20	22	27	34	41	42	33
Southwest	1	14	23	32	45	51	52	34	24	19
	2	26	24	22	25	27	30	33	34	33
	3	22	21	22	25	29	35	38	37	33
	4	22	20	20	22	27	34	39	39	36
South	1	14	24	36	43	43	38	30	23	20
	2	24	23	23	24	26	28	30	30	29
	3	21	20	21	25	29	22	23	22	21
	4	20	19	19	23	28	322	39	33	31
Southeast	1	23	40	44	42	40	37	30	23	19
	2	25	24	25	28	30	31	32	32	31
	3	22	23	27	31	33	34	34	33	30
	4	21	20	24	29	33	35	36	35	32
East	1	29	47	46	41	40	37	30	23	19
	2	26	25	27	30	31	33	33	33	32
	3	22	24	29	33	35	35	35	34	31
	4	21	22	27	32	35	36	37	35	33
Northeast	1	27	30	40	40	40	37	30	23	19
	2	25	24	26	28	29	31	31	32	31
	3	22	23	27	30	32	33	34	32	30
	4	21	21	25	29	32	34	35	34	32
Roof	1	39	70	88	88	72	43	26	23	21
	2	20	22	33	49	63	69	66	57	47
	3	17	33	56	75	82	74	56	40	30

EQUIVALENT TEMPERATURE DIFFERENCE FOR MEDIUM COLOURED (=0.7) WALLS AND ROOFS IN ALLAHABAD

Based on114^{O}F Outdoor Design Temp; Constant 75^{O}F db Room . Temperature; 10^{O}F Daily Range; June and 25^{O}25; N Lat.

Exposure	Type of Wall	SUN TIME AM 8	10	12	PM 2	4	6	8	10	12
North	1	36	40	42	44	46	46	47	32	30
	2	35	35	35	36	37	38	39	39	39
	3	34	34	36	37	39	40	41	40	38
	4	33	33	35	37	38	40	42	41	39
Northwest	1	31	37	41	47	59	60	42	33	30
	2	37	36	36	37	38	40	42	43	42
	3	35	34	35	37	39	43	46	45	42
	4	34	33	34	35	38	42	47	47	44
West	1	31	37	40	49	63	64	43	33	30
	2	38	37	37	37	38	41	43	45	44
	3	35	35	35	37	40	45	48	47	43=
	4	34	33	34	35	38	44	49	49	46
Southwest	1	31	37	41	49	57	54	39	32	30
	2	36	36	36	36	37	39	41	42	41
	3	34	34	35	37	39	43	45	43	41
	4	34	33	33	35	38	42	46	45	42
South	1	32	37	43	46	45	41	35	32	30
	2	34	34	34	35	36	37	38	38	37
	3	33	33	34	36	38	39	39	38	37
	4	32	32	33	35	38	40	40	39	38
Southeast	1	41	51	51	46	45	40	35	31	30
	2	36	36	37	39	40	41	41	40	39
	3	34	36	39	42	42	42	42	40	38
	4	33	34	38	41	43	43	43	41	39
East	1	49	60	54	46	45	40	35	31	30
	2	36	37	39	42	43	43	43	42	41
	3	35	38	43	45	45	44	43	41	39
	4	33	36	41	45	46	46	45	42	40
Northeast	1	47	55	51	45	44	40	35	31	30
	2	36	36	38	40	41	42	42	41	40
	3	34	36	41	43	43	43	42	40	38
	4	33	35	40	43	44	44	44	42	39
Roof	1	57	82	95	92	78	49	34	33	32
	2	34	37	48	62	73	78	74	64	55
	3	34	50	70	85	89	81	62	48	38

EQUIVALENT TEMPERATURE DIFFERENCE FOR MEDIUM COLOURED (α=0.7) WALLS AND ROOFS IN ALLAHABAD

Based on 93°F Outdoor Design Temp; Constant 75°F db Room Temperature; 7°F Daily Range; August and 25°25' N Lat.

Exposure	Type of Wall	SUN TIME AM 8	10	12	PM 2	4	6	8	10	12
North	1	17	20	24	26	27	26	19	14	12
	2	17	16	17	18	19	19	20	20	20
	3	15	16	17	19	20	21	22	20	20
	4	15	15	16	18	20	21	23	22	20
Northwest	1	13	18	23	28	39	41	23	15	12
	2	18	22	31	35	45	26	23	23	22
	3	16	16	17	18	21	25	28	26	23
	4	16	15	15	17	20	24	28	28	26
West	1	13	18	22	31	46	46	24	15	22
	2	20	19	19	19	20	22	25	27	26
	3	17	17	17	19	22	27	30	29	25
	4	16	15	16	17	20	26	31	31	28
Southwest	1	23	18	23	322	41	37	21	14	12
	2	19	18	18	18	20	22	24	24	24
	3	16	16	17	19	22	26	28	26	23
	4	16	15	15	17	20	25	29	28	25
South	1	14	19	27	30	28	23	17	14	13
	2	17	16	16	17	19	20	21	20	20
	3	15	15	16	19	21	22	22	21	19
	4	14	14	15	17	21	23	23	22	20
Southwest	1	23	35	35	29	26	22	17	13	12
	2	18	18	19	21	23	23	23	23	22
	3	16	19	21	24	25	25	24	22	20
	4	15	16	20	24	26	26	25	24	21
East	1	30	43	37	28	26	22	17	23	22
	2	18	19	21	24	25	25	25	25	23
	3	16	20	25	27	27	26	25	23	21
	4	15	17	23	27	28	27	24	22	19
Northeast	1	28	36	31	27	26	22	17	23	12
	2	18	18	20	22	23	27	23	22	21
	3	16	19	22	24	25	25	24	22	20
	4	15	17	21	25	25	26	25	24	21
Roof	1	38	63	77	74	59	29	16	15	14
	2	16	19	30	44	55	66	56	46	36
	3	15	31	51	67	71	62	43	29	21

EQUIVALENT TEMPERATURE DIFFERENCE FOR MEDIUM COLOURED ($\alpha=0.7$)

WALLS AND ROOFS IN AMRITSAR

Based on 110°F Outdoor Design Temp; Constant 75°F db Room Temperature; 21°F Daily Range; June and 31°35'N Lat.

Exposure	Type of Wall	SUN TIME AM 8	10	12	PM 2	4	6	8	10	12
North	1	22	28	35	41	43	44	45	36	33
	2	26	26	25	26	28	30	32	33	33
	3	24	23	25	27	30	33	35	35	32
	4	23	22	23	26	29	33	36	36	34
Northwest	1	16	25	34	43	55	60	47	32	22
	2	28	27	26	27	29	31	35	37	36
	3	25	23	24	27	31	36	40	40	37
	4	24	22	22	25	29	35	41	43	39
West	1	16	25	33	46	61	64	42	27	22
	2	29	28	27	28	29	33	36	38	38
	3	25	24	25	27	32	38	43	42	38
	4	23	22	23	27	33	40	45	44	41
Southwest	1	17	25	34	47	56	54	39	26	21
	2	28	27	26	27	29	32	35	36	35
	3	24	23	24	27	32	37	40	39	36
	4	24	22	22	25	29	36	41	41	38
South	1	17	26	38	45	44	40	32	25	12
	2	26	25	25	26	28	30	32	32	32
	3	23	22	24	27	31	34	35	34	32
	4	23	21	22	25	30	34	36	36	33
Southeast	1	27	41	46	44	43	40	32	35	25
	2	27	27	28	30	32	333	34	34	33
	3	24	25	29	33	35	36	37	35	33
	4	23	23	26	31	35	37	38	37	34
East	1	35	49	47	43	42	39	32	25	21
	2	28	28	30	32	34	35	36	36	34
	3	25	27	32	36	37	38	38	36	33
	4	23	25	30	35	37	39	39	38	35
Northeast	1	33	43	41	42	39	32	25	23	21
	2	27	27	29	31	32	33	34	34	33
	3	24	27	31	33	35	36	36	35	33
	4	23	24	28	32	35	37	38	37	34
Roof	1	45	73	89	90	76	50	29	25	22
	2	23	26	37	52	65	72	70	61	51
	3	24	38	60	78	84	78	61	44	33

EQUIVALENT TEMPERATURE DIFFERENCE FOR MEDIUM COLOURED ($\alpha=0.7$) WALLS AND ROOFS IN AMRITSAR

Based on 95°F Outdoor Design Temp; Constant 75°F db Room Temperature; 9°F Daily Range; August and 31°35'N Lat.

Exposure	Type of Wall	SUN TIME								
		AM			PM					
		8	10	12	2	4	6	8	10	12
North	1	15	19	23	25	26	24	18	14	12
	2	16	16	16	17	18	19	20	20	19
	3	15	15	16	18	19	21	21	20	19
	4	14	14	15	17	19	21	22	21	20
Northwest	1	13	18	23	26	36	39	23	15	12
	2	18	18	17	18	19	20	23	24	23
	3	16	16	17	18	20	23	26	25	23
	4	16	15	15	17	19	23	27	27	24
West	1	13	18	22	31	46	46	24	15	12
	2	20	19	19	19	20	22	25	27	26
	3	17	17]	17	19	22	27	30	29	25
	4	16	15	16	17	20	26	27	31	28
Southwest	1	13	18	24	35	45	39	22	14	12
	2	19	18	18	19	20	23	25	26	25
	3	17	16	17	19	23	27	29	27	24
	4	16	15	15	17	21	26	30	30	26
South	1	14	22	32	35	33	24	17	14	12
	2	18	17	17	19	20	22	23	23	21
	3	16	16	17	20	24	25	25	23	20
	4	15	14	16	19	23	26	26	24	22
Southeast	1	24	37	39	31	27	22	17	13	12
	2	18	18	20	22	24	25	24	24	22
	3	16	18	22	26	27	26	25	23	21
	4	15	16	21	25	28	28	27	24	22
East	1	30	43	37	37	36	33	17	12	12
	2	18	19	21	24	26	25	25	24	22
	3	16	20	25	27	27	26	25	24	21
	4	15	17	23	27	28	28	26	24	22
Northeast	1	26	33	28	26	26	22	17	13	12
	2	17	18	19	21	22	22	22	22	21
	3	16	18	22	23	23	24	23	21	20
	4	15	17	20	23	24	24	24	23	20
Roof	1	37	62	75	72	58	29	16	15	14
	2	16	19	29	33	54	59	54	45	36
	3	15	30	50	65	69	60	42	29	20

EQUIVALENT TEMPERATURE DIFFERENCE FOR MEDIUM COLOURED (α=0.7) WALLS AND ROOFS IN BOMBAY

Based on 98°F Outdoor Design Temp; Constant 75°F db Room Temperature; 5°F Daily Range; May and 18°54' N Lat.

Exposure	Type of Wall	SUN TIME AM 8	10	12	PM 2	4	6	8	10	12
North	1	22	26	28	29	30	29	22	20	19
	2	22	22	22	23	24	24	25	25	24
	3	21	21	22	24	25	26	26	25	24
	4	20	20	22	23	25	26	27	26	24
Northwest	1	19	24	27	34	43	42	26	20	18
	2	24	23	23	24	25	26	28	29	28
	3	22	22	23	24	26	29	32	30	28
	4	22	21	21	23	25	29	32	32	29
West	1	19	24	27	35	49	47	27	20	18
	2	25	24	24	24	25	27	30	31	30
	3	23	22	23	24	27	31	34	32	29
	4	22	21	22	23	25	30	35	35	31
Southwest	1	19	24	28	35	43	39	24	20	18
	2	24	23	23	24	25	26	28	29	28
	3	22	22	22	24	26	30	31	30	27
	4	21	21	21	23	25	29	32	31	29
South	1	20	25	30	32	30	35	21	19	19
	2	22	21	22	22	23	24	25	25	24
	3	21	21	22	23	25	26	26	25	23
	4	20	20	21	23	25	26	27	25	24
Southeast	1	28	40	38	32	29	25	21	19	19
	2	23	23	25	26	28	28	28	27	27
	3	21	23	27	29	30	29	28	26	25
	4	20	22	25	29	30	30	29	27	25
East	1	34	49	41	32	29	24	21	19	19
	2	24	24	26	29	30	30	29	28	26
	3	22	25	30	32	32	31	29	27	25
	4	21	23	28	32	33	32	31	29	26
Northeast	1	31	43	37	21	29	25	21	19	19
	2	23	23	25	27	28	28	28	27	26
	3	22	24	28	30	30	29	28	26	25
	4	20	22	27	30	31	30	29	27	25
Roof	1	42	69	81	78	61	31	21	21	21
	2	21	24	35	49	60	64	59	49	40
	3	20	36	56	71	75	64	46	33	26

EQUIVALENT TEMPERATURE DIFFERENCE FOR MEDIUM COLOURED (=0.7) WALLS AND ROOFS IN BOMBAY

Based on 87°F Outdoor Design Temp; Constant 75°F db Room Temperature; 2°F Daily Range; August and 18°54' N Lat.

Exposure	Type of Wall	SUN TIME								
		AM			PM					
		8	10	12	2	4	6	8	10	12
North	1	14	17	19	19	19	18	13	11	10
	2	13	13	13	14	14	15	16	15	15
	3	12	12	14	15	16	16	16	16	14
	4	11	12	13	14	16	17	17	16	15
Northwest	1	11	15	18	22	33	32	16	11	10
	2	15	14	14	15	15	17	19	20	19
	3	13	13	14	15	17	20	22	21	18
	4	13	12	13	14	16	19	23	22	20
West	1	11	15	17	25	39	37	17	11	10
	2	16	15	15	15	16	18	21	21	20
	3	14	13	14	15	17	22	25	23	20
	4	13	12	13	14	16	21	25	25	22
Southwest	1	11	15	18	25	33	29	15	11	10
	2	15	14	14	15	15	17	19	19	18
	3	13	13	14	15	17	20	22	20	18
	4	12	12	12	14	16	20	23	22	19
South	1	11	16	20	20	20	15	12	10	10
	2	13	12	13	13	14	15	15	15	15
	3	12	12	13	14	16	17	16	15	14
	4	11	11	12	14	16	17	17	16	14
Southeast	1	20	31	29	22	19	16	11	10	10
	2	14	14	16	17	18	19	18	17	17
	3	12	14	18	20	20	20	18	17	15
	4	11	13	17	20	21	21	20	18	16
East	1	25	39	32	22	19	15	11	10	10
	2	14	15	17	20	20	20	20	19	18
	3	13	16	21	23	22	21	19	19	16
	4	12	14	19	23	24	23	21	19	16
Northeast	1	23	33	27	21	19	15	11	10	10
	2	14	14	16	18	19	19	18	18	17
	3	13	15	19	21	20	20	18	17	15
	4	11	13	18	21	21	21	19	18	16
Roof	1	33	59	72	68	51	21	12	12	12
	2	13	15	26	40	50	54	49	39	31
	3	12	27	47	62	65	64	38	24	17

EQUIVALENT TEMPERATURE DIFFERENCE FOR MEDIUM COLOURED (α=0.7) WALLS AND ROOFS IN DELHI

Based on 110°F; Outdoor Design Temp; Constant 75°F db Room Temperature; 12°F Daily Range; June and 28°38' N Lat.

Exposure	Type of Wall	SUN TIME AM 8	10	12	PM 2	4	6	8	10	12
North	1	33	35	40	41	42	43	32	33	6
	2	24	24	26	28	29	31	32	33	32
	3	21	24	27	20	22	34	35	34	33
	4	19	22	25	29	32	35	37	37	35
Northwest	1	28	32	38	44	54	58	38	34	6
	2	26	26	26	28	30	32	35	37	37
	3	22	24	26	29	33	37	41	40	37
	4	20	22	24	28	31	37	42	43	40
West	1	28	32	38	47	59	62	38	34	6
	2	26	26	27	28	30	33	37	38	38
	3	33	24	27	30	34	39	43	42	39
	4	21	22	24	28	32	38	44	45	42
Southwest	1	28	32	39	47	54	51	34	33	6
	2	25	25	26	27	29	32	35	36	35
	3	22	24	26	29	33	37	40	38	36
	4	20	21	24	27	32	37	41	41	39
South	1	28	33	41	44	42	38	30	33	6
	2	23	23	24	26	28	30	31	32	31
	3	21	23	25	29	32	34	34	33	32
	4	19	21	23	28	32	35	36	35	34
Southeast	1	37	47	49	44	41	38	29	32	6
	2	24	21	27	30	32	34	34	34	33
	3	22	25	30	34	36	37	36	34	33
	4	19	22	28	34	37	38	38	37	35
East	1	46	56	52	43	41	37	29	32	66
	2	25	26	30	33	35	36	36	35	34
	3	32	28	34	38	39	39	38	36	34
	4	19	24	32	38	40	40	40	38	36
Northeast	1	44	51	38	42	41	37	29	32	6
	2	24	26	29	32	33	34	35	34	33
	3	22	27	33	36	37	37	37	35	33
	4	19	24	30	35	38	39	38	37	35
Roof	1	53	80	89	92	70	50	29	26	22
	2	21	27	40	55	68	74	71	62	52
	3	25	43	43	66	81	87	77	59	45

EQUIVALENT TEMPERATURE DIFFERENCE FOR MEDIUM COLOURED (α=0.7) WALLS AND ROOFS IN DELHI

Based on 98°F Outdoor Design Temp; Constant 75°F db Room Temperature; 8°F Daily Range; August and 28°38' N Lat.

Exposure	Type of Wall	SUN TIME								
		AM							M	
		8	10	12	2	4	6	8	10	12
North	1	21	24	27	29	30	29	23	18	16
	2	21	20	21	21	22	23	24	24	24
	3	19	20	21	22	24	25	26	25	23
	4	19	19	20	22	24	25	26	26	24
Northwest	1	17	22	27	31	42	45	28	19	16
	2	23	22	22	22	23	25	27	28	28
	3	20	20	21	22	25	28	31	30	27
	4	20	19	20	21	23	27	34	32	29
West	1	17	22	26	35	50	50	29	19	16
	2	24	23	23	23	24	27	29	31	30
	3	21	21	21	23	26	31	34	33	29
	4	20	19	20	21	24	30	35	35	32
Southwest	1	17	22	27	37	46	42	25	18	16
	2	23	22	22	22	24	26	28	29	28
	3	20	20	21	23	26	30	32	30	27
	4	20	19	19	21	25	30	33	33	29
South	1	18	24	32	36	34	27	21	18	16
	2	21	20	21	22	23	25	25	25	24
	3	19	19	21	23	26	27	27	25	23
	4	22	31	36	34	28	21	18	17	16
Southeast	1	28	35	40	33	31	26	21	17	16
	2	22	22	24	26	27	28	28	272	26
	3	21	22	26	29	30	29	28	26	24
	4	19	20	24	28	30	31	30	28	25
East	1	35	47	41	32	30	26	21	17	16
	2	22	23	25	28	29	29	29	28	27
	3	21	24	29	31	31	30	29	27	25
	4	19	22	27	31	32	32	31	28	26
Northeast	1	32	40	34	30	30	26	31	17	16
	2	22	22	24	262	26	27	27	26	25
2	3	20	23	26	28	28	28	28	27	24
	4	19	21	25	28	29	29	29	27	25
Roof	1	42	67	81	78	63	34	20	19	18
	2	20	23	34	48	59	64	59	50	40
	3	19	35	55	70	75	66	48	33	35

EQUIVALENT TEMPERATURE DIFFERENCE FOR MEDIUM COLOURED (α=0.7) WALLS AND ROOFS IN MADRAS

Based on 102°F Outdoor Design Temp; Constant 75°F db Room Temperature; 15°F Daily Range; June and 13°8' N Lat.

Exposure	Type of Wall	SUN TIME AM 8	10	12	PM 2	4	6	8	10	12
North	1	19	28	34	38	41	37	27	22	19
	2	23	22	23	24	25	27	29	29	28
	3	20	20	23	25	28	21	22	20	18
	4	20	19	21	24	27	31	33	32	30
Northwest	1	14	21	27	39	52	49	30	22	19
	2	24	23	22	23	24	27	30	31	30
	33	21	20	21	23	26	32	35	34	31
	4	21	19	19	20	24	31	36	36	33
West	1	14	21	26	37	53	50	30	22	19
	2	24	23	22	23	24	27	30	31	30
	3	21	20	21	22	26	32	35	34	31
	4	21	19	19	20	24	30	36	36	33
Southwest	1	14	21	27	33	42	39	27	22	19
	2	22	21	22	22	23	25	27	28	27
	3	20	19	20	22	24	28	30	29	27
	4	20	18	18	20	23	27	31	31	29
South	1	15	21	27	32	33	30	25	21	19
	2	21	20	20	21	22	23	24	25	24
	3	19	18	19	21	24	26	26	26	25
	4	19	18	18	20	23	25	27	27	26
Southeast	1	21	32	32	33	33	30	25	21	19
	2	22	21	22	23	25	26	26	26	26
	3	20	20	23	25	27	28	28	27	27
	4	19	19	21	24	26	28	29	28	27
East	1	28	43	40	34	33	29	25	21	19
	2	23	23	25	27	28	29	29	29	28
	3	20	22	27	30	31	31	30	29	27
	4	19	20	25	29	31	32	32	30	28
Northeast	1	27	42	41	36	34	30	25	21	19
	2	23	23	24	27	28	29	29	29	28
	3	20	22	27	30	31	31	30	29	27
	4	19	20	25	29	31	32	32	30	28
Roof	1	37	65	81	80	64	35	24	21	20
	2	19	21	31	46	58	64	60	51	42
	3	16	32	53	70	75	67	49	36	25

SECTION 5.4 SOLAR HEAT GAINS FOR SOME LOCATIONS IN INDIA

SUN TIME	DIRECT RAD.	DIFFUSED RAD.	REFLECTED RAD.	TRANSMISSIVITY	SOLAR HT.GAIN

SOLA- RADIATION INTENSITIES AND SOLAR HEAT GAINS FOR
ALLAHABAD

HOUP ANGLE AT SUNRISE 101.08 DEGREES
LATITUDE 25.500 JUNE DATE 1

WALL ANGLE MEASURED FROM NORTH 0.00DEGREES

6	32.561	9.610	4.269	0.676	31.851
7	46.916	18.251	15.384	0.532	48.835
8	33.360	20.321	25.922	0.344	44.305
9	14.461	20.598	34.956	0.140	41.475
10	0.000	20.407	41.878	0.000	44.222
11	0.000	20.192	46.225	0.000	47.156
12	0.000	20.108	47.707	0.000	48.149
13	0.000	20.192	46.225	0.000	47.156
14	0.000	20.407	41.878	0.000	44.222
15	14.461	20.598	34.956	0.140	41.475
16	33.360	20.321	25C922	0.344	44.305
17	46.916	18.251	15.384	0.532	48.835
18	32.561	9.610	4.269	0.676	31.851

WALL ANGLE MEASURED FROM NORTH 45.00DEGREES

6	0.000	5.69^	4.269	0.000	7.071
7	0.000	11.819	15.384	0.000	19.314
8	0.000	14.28^	25.922	0.000	28.544
9	0.000	15.493	34.956	0.000	35.819
10	0.000	16.139	41.878	0.000	41.192
11	0.000	16.465	46.225	0.000	44.510
12	0.000	20.382	47.707	0.000	48.344
13	37.862	23.387	46.225	0.339	62.263
14	88.133	26.892	41.878	0.658	106.781
15	132.084	30.237	34.956	0.809	153.078
16	161.158	32.110	25.922	0.867	181.006
17	160.169	29.789	15C384	0.888	174.315
18	86.320	15.535	4.269	0.895	91.277

WALL ANGLE MEASURED FROM NORTH 90.00DEGREES

6	0.000	5.69^	4.269	0.000	7.071
7	0.000	11.819	15.384	0.000	19.314
8	0.000	14.281	25.922	0.000	28.544
9	0.000	15.493	34.956	0.000	35.819
10	0.000	16.139	41.878	0.000	41.192
11	0.000	16.465	46.225	0.000	44.510
12	0.000	21.079	47.707	0.000	48.838

13	67.036	25.555	46.225	0.542	87.288
14	126.944	30.444	41.878	0.786	151.074
15	172.334	34.550	34.956	0.865	198.467
16	194.552	36.122	25.922	0.888	216.906
17	179.597	32.308	15.384	0.895	194.526
18	89.514	15.966	4.269	0.896	94.548

WALL ANGLE MEASURED FROM NORTH 135.00DEGREES

6	0.000	5.69^	4.269	0.000	7.071
7	0.000	11.819	15.384	0.000	19.314
8	0.000	14.281	25.922	0.000	28.544
9	0.000	15.493	34.956	0.000	35.819
10	0.000	16.139	41.878	0.000	41.192
11	0.000	18.953	46.225	0.000	46.277
12	12.262	21.822	47.707	0.110	50.714
13	56.942	24.776	46.225	0.479	77.684
14	91.394	27.172	41.878	0.672	110.403
15	111.633	28.244	34.956	0.758	129.494
16	113.980	27.099	25.922	0.790	127.682
17	93.820	22.37*	15.384	0.788	100.770
18	40.272	10.305	4.269	0.752	40.636

WALL ANGLE MEASURED FROM NORTH 180.00DEGREES

6	0.000	5.69^	4.269	0.000	7.071
7	0.000	11.819	15.384	0.000	19.314
8	0.000	16.414	25.922	0.000	30.059
9	0.000	18.904	34.956	0.000	38.241
10	2.306	20.677	41.878	0.015	44.449
11	13.492	21.772	46.225	0.122	49.931
12	17.396	22.146	47.707	0.159	52.356
13	13.492	21.772	46.225	0.122	49.931
14	2.306	20.677	41.878	0.015	44.449
15	0.000	18.904	34.956	0.000	38.241
16	0.000	16.414	25.922	0.000	30.059
17	0.000	11.819	15C384	0.000	19.314
18	0.000	5.69^	4.269	0.000	7.071

WALL ANGLE MEASURED FROM NORTH 225.00DEGREES

6	40.272	10.305	4.269	0.752	40.636
7	93.820	22.378	15.384	0.788	100.770
8	113.980	27.099	25.922	0.790	127.682
9	111.633	28.243	34.956	0.758	129.494
10	91.394	27.172	41.878	0.672	110.403
11	56.942	24.776	46.225	0.479	77.684
12	12.340	21.827	47.707	0.111	50.735
13	0.000	18.953	46.225	0.000	46.277
14	0.000	16.139	41.878	0.000	41.192
15	0.000	15.493	34C956	0.000	35.819
16	0.000	14.281	25.922	0.000	28.544
17	0.000	11.819	15.384	0.000	19.314
18	0.000	5.69^	4.269	0.000	7.071

WALL ANGLE MEASURED FROM NORTH 270.00DEGREES

6	89.514	15.966	4.269	0.896	94.548
7	179.597	32.308	15.384	0.895	194.526
8	194.552	36.122	25.922	0.888	216.906
9	172.334	34.55[illegible]	34.956	0.865	198.467
10	126.944	30.444	41.878	0.786	151.074
11	67.036	25.555	46.225	0.542	87.288
12	0.055	21.085	47.707	0.000	48.843
13	0.000	16.465	46.225	0.000	44.510
14	0.000	16.139	41.878	0.000	41.192
15	0.000	15.493	34.956	0.000	35.819
16	0.000	14.281	25.922	0.000	28.544
17	0.000	11.819	15.384	0.000	19.314
18	0.000	5.690	4.269	0.000	7.071

WALL ANGLE MEASURED FROM NORTH 315.00DEGREES

6	86.320	15.535	4.269	0.895	91.277
7	160.169	29.789	15.384	0.888	174.315
8	161.158	32.110	25.922	0.867	181.006
9	132.084	30.237	34.956	0.809	153.078
10	88.133	26.892	41.878	0.658	106.781
11	37.862	23.387	46.225	0.339	62.263
12	0.000	20.386	47.707	0.000	48.347
13	0.000	16.465	46.225	0.000	44.510
14	0.000	16.139	41.878	0.000	41.192
15	0.000	15.493	34.956	0.000	35.819
16	0.000	14.281	25.922	0.000	28.544
17	0.000	11.819	15.384	0.000	19.314
18	0.000	5.69[illegible]	4.269	0.000	7.071

WALL ANGLE MEASURED FROM NORTH 360.00DEGREES

6	15.531	12.932	4.269	0.394	18.335
7	75.695	26.862	15.384	0.717	84.295
8	140.360	32.456	25.922	0.843	159.720
9	197.831	35.210	34.956	0.883	224.474
10	242.505	36.680	41.878	0.894	272.609
11	270.748	37.419	46.225	0.897	302.169
12	280.403	37.646	47.707	0.897	312.142
13	270.748	37.419	46.225	0.897	302.169
14	242.505	36.680	41.878	0.894	272.609
15	197.831	35.210	34.956	0.883	224.474
16	140.360	32.456	25.922	0.843	159.720
17	75.695	26.862	15.384	0.717	84.295
18	15.531	12.932	4.269	0.394	18.335

SOLA- RADIATION INTENSITIES AND SOLAR HEAT GAINS FOR

ALLAHABAD

HOUR ANGLE AT SUNRISE 99.02 DEGREES

LATITUDE 25.500 AUGUST DATE 1

WALL ANGLE MEASURED FROM NORTH 0.00DEGREES

6	22.193	6.801	3.029	0.605	20.415
7	35.158	15.754	14.330	0.425	36.311
8	19.018	17.853	25.247	0.199	34.384
9	0.000	18.178	34.629	0.000	37.493
10	0.000	18.049	41.825	0.000	42.511
11	0.000	17.883	46.347	0.000	45.603
12	0.000	17.817	47.889	0.000	46.651
13	0.000	17.883	46.347	0.000	45.603
14	0.000	18.049	41.825	0.000	42.511
15	0.000	18.178	34.629	0.000	37.493
16	19.018	17.853	25.247	0.199	34.384
17	35.158	15.754	14.330	0.425	36.311
18	22.193	6.801	3.029	0.605	20.415

WALL ANGLE MEASURED FROM NORTH 45.00DEGREES

6	0.000	4.226	3.029	0.000	5.151
7	0.000	10.720	14.330	0.000	17.785
8	0.000	13.186	25.247	0.000	27.287
9	0.000	14.364	34.629	0.000	34.785
10	0.000	14.983	41.825	0.000	40.334
11	0.000	15.291	46.347	0.000	43.763
12	0.000	18.295	47.889	0.000	46.991
13	26.738	20.983	46.347	0.240	54.232
14	79.479	24.170	41.825	0.609	95.292
15	125.723	27.240	34.629	0.789	143.180
16	156.348	28.918	25.247	0.860	172.980
17	154.430	26.437	14.330	0.885	165.673
18	68.575	11.315	3.029	0.893	71.448

WALL ANGLE MEASURED FROM NORTH 90.00DEGREES

6	0.000	4.226	3.029	0.000	5.151
7	0.000	10.720	14.330	0.000	17.785
8	0.000	13.186	25.247	0.000	27.287
9	0.000	14.364	34.629	0.000	34.785
10	0.000	14.983	41.825	0.000	40.334
11	0.000	15.291	46.347	0.000	43.763
12	0.000	19.579	47.889	0.000	47.902
13	70.039	23.853	46.347	0.551	88.452
14	132.573	28.541	41.825	0.793	155.044
15	179.746	32.475	34.629	0.869	203.826
16	202.091	33.906	25.247	0.890	221.892
17	183.240	29.833	14.330	0.895	195.431
18	74.786	12.079	3.029	0.896	77.759

WALL ANGLE MEASURED FROM NORTH 135.00DEGREES

6	0.000	4.226	3.029	0.000	5.151
7	0.000	10.720	14.330	0.000	17.785
8	0.000	13.186	25.247	0.000	27.287
9	0.000	14.364	34.629	0.000	34.785

10	0.000	14.983	41.825	0.000	40.334
11	0.000	18.132	46.347	0.000	45.780
12	25.718	21.041	47.889	0.230	54.858
13	72.312	24.018	46.347	0.564	90.733
14	108.007	26.423	41.825	0.726	126.882
15	128.477	27.487	34.629	0.796	146.340
16	129.452	26.289	25.247	0.821	142.842
17	104.710	21.322	14.330	0.820	111.124
18	37.189	8.032	3.029	0.791	37.271

WALL ANGLE MEASURED FROM NORTH 180.00DEGREES

6	0.000	4.226	3.029	0.000	5.151
7	0.000	12.005	14.330	0.000	18.698
8	0.000	15.825	25.247	0.000	29.161
9	1.948	18.386	34.629	0.012	37.665
10	20.172	20.200	41.825	0.186	47.784
11	32.226	21.319	46.347	0.287	57.297
12	36.419	21.700	47.889	0.320	61.052
13	32.226	21.319	46.347	0.287	57.297
14	20.172	20.200	41.825	0.186	47.784
15	1.948	18.386	34.629	0.012	37.665
16	0.000	15.825	25.247	0.000	29.161
17	0.000	12.005	14.330	0.000	18.698
18	0.000	4.226	3.029	0.000	5.151

WALL ANGLE MEASURED FROM NORTH 225.00DEGREES

6	37.189	8.032	3.029	0.791	37.271
7	104.710	21.322	14.330	0.820	111.124
8	129.452	26.289	25.247	0.821	142.842
9	128.477	27.487	34.629	0.796	146.340
10	108.007	26.423	41.825	0.726	126.882
11	72.312	24.018	46.347	0.564	90.733
12	25.786	21.045	47.889	0.231	54.892
13	0.000	18.132	46.347	0.000	45.780
14	0.000	14.983	41.825	0.000	40.334
15	0.000	14.364	34.629	0.000	34.785
16	0.000	13.186	25.247	0.000	27.287
17	0.000	10.720	14.330	0.000	17.785
18	0.000	4.226	3.029	0.000	5.151

WALL ANGLE MEASURED FROM NORTH 270.00DEGREES

6	74.786	12.079	3.029	0.896	77.759
7	183.240	29.833	14.330	0.895	195.431
8	202.091	33.906	25.247	0.890	221.892
9	179.746	32.475	34.629	0.869	203.826
10	132.573	28.541	41.825	0.793	155.044
11	70.039	23.853	46.347	0.551	88.452
12	0.048	19.584	47.889	0.000	47.906
13	0.000	15.291	46.347	0.000	43.763
14	0.000	14.983	41.825	0.000	40.334
15	0.000	14.364	34.629	0.000	34.785

16	0.000	13.186	25.247	0.000	27.287
17	0.000	10.720	14.330	0.000	17.785
18	0.000	4.226	3.^29	0.000	5.151

WALL ANGLE MEASURED FROM NORTH 315.00DEGREES

6	68.575	11.315	3.029	0.893	71.448
7	154.430	26.437	14.330	0.885	165.673
8	156.348	28.918	25.247	0.860	172.980
9	125.723	27.240	34.629	0.789	143.180
10	79.479	24.170	41.825	0.609	95.292
11	26.738	20.983	46.347	0.240	54.232
12	0.000	18.299	47.889	0.000	46.993
13	0.000	15.291	46.347	0.000	43.763
14	0.000	14.983	41C825	0.00C	40.334
15	0.000	14.364	34.629	0.000	34.785
16	0.000	13.186	25.247	0.000	27.287
17	0.000	10.72^	14.330	0.000	17.785
18	0.000	4.226	3.^29	0.000	5.151

WALL ANGLE MEASURED FROM NORTH 360.00DEGREES

6	10.586	9.604	3.029	0.337	12.532
7	71.168	24.363	14.330	0.696	77.017
8	138.342	29.969	25.247	0.836	154.920
9	198.217	32.646	34.629	0.881	222.432
10	244.784	34.051	41.*25	0.894	272.636
11	274.227	34.753	46.347	0.897	303.449
12	284.293	34.967	47.889	0.897	313.840
13	274.227	34.753	46.347	0.897	303.449
14	244.784	34.051	41.825	0.894	272.636
15	198.217	32.646	34.629	0.881	222.432
16	138.342	29.969	25.247	0.836	154.920
17	71.168	24.363	4.330	0.696	77.017
18	10.586	9.604	3.029	0.337	12.532

SOLA- RADIATION INTENSITIES AND SOLAR HEAT GAINS FOR

AHEMACABAD

HOUR ANGLE AT SUNRISE 96.46 DEGREES
LATITUDE 23.000 MAY DATE 1
WALL ANGLE MEASURED FROM NORTH 0.0(DEGREES

6	11.663	4.071	1.640	0.535	10.294
7	26.721	14.658	13.^96	0.345	28.920
8	11.500	17.181	24.404	0.119	30.896
9	0.000	17.696	34.120	0.000	36.790
10	0.000	17.676	41.569	0.000	42.065
11	0.000	17.569	46.250	0.000	45.312
12	0.000	17.522	47.846	0.000	46.411
13	0.000	17.569	46.250	0.000	45.312
14	0.000	17.676	41.569	0.000	42.065

15	0.000	17.696	34.120	0.000	36.790
16	11.500	17.181	24.404	0.119	30.896
17	26.721	14.658	13.096	0.345	28.920
18	11.663	4.071	1.640	0.535	10.294

WALL ANGLE MEASURED FROM NORTH 45.00DEGREES

6	0.000	2.632	1.640	0.000	3.033
7	0.000	10.297	13.096	0.000	16.609
8	0.000	13.005	24.404	0.000	26.561
9	0.000	14.243	34.120	0.000	34.338
10	0.000	14.878	41.569	0.000	40.078
11	0.000	15.191	46.250	0.000	43.623
12	0.000	18.042	47.846	0.000	46.780
13	24.470	20.708	46.250	0.220	52.926
14	77.486	23.847	41.569	0.599	92.849
15	123.399	26.808	34.120	0.784	140.001
16	152.725	28.244	24.404	0.857	168.314
17	146.577	25.063	13.096	0.884	156.594
18	42.036	6.926	1.640	0.892	43.584

WALL ANGLE MEASURED FROM NORTH 90.00DEGREES

6	0.000	2.632	1.640	0.000	3.033
7	0.000	10.297	13.096	0.000	16.609
8	0.000	13.005	24.404	0.000	26.561
9	0.000	14.243	34.120	0.000	34.338
10	0.000	14.878	41.569	0.000	40.078
11	0.000	15.191	46.250	0.000	43.623
12	0.000	19.453	47.846	0.000	47.782
13	71.385	23=786	46.250	0.558	89.565
14	135.059	28.549	41.569	0.798	157.512
15	182.845	32.528	34.120	0.871	206.646
16	2^4.487	33.848	24.404	0.891	223.609
17	180.571	29.038	13.096	0.896	191.690
18	47.785	7.626	1||640	0.897	49.425

WALL ANGLE MEASURED FROM NORTH 135.00DEGREES

6	0.000	2.632	1.640	0.000	3.033
7	0.000	10.297	13.096	0.000	16.609
8	0.000	13.005	24.304	0.000	26.561
9	0.000	14.243	34.120	0.000	34.338
10	0.000	14.878	41.569	0.000	40.078
11	0.000	18.120	46.250	0.000	45.703
12	28.745	21.085	47.846	0.256	56.293
13	76.483	24.155	46.250	0.585	94.762
14	113.515	26.684	41C569	0.743	132.803
15	135.182	27.862	34.120	0.810	153.494
16	136.462	26.655	24.404	0.835	150.150
17	1^8.788	21.175	13.096	0.836	115.300
18	25.542	5.20^	1.640	0.816	25.693

WALL ANGLE MEASURED FROM NORTH 180.00DEGREES

6	0.000	2.632	1.640	0.000	3.033

13	0.000	15.191	46.250	0.000	43.623
14	0.000	14.878	41.569	0.000	40.078
15	0.000	14.243	34.120	0.000	34.338
16	0.000	13.005	24.404	0.000	26.561
17	0.000	10.297	13.096	0.000	16.609
18	0.000	2.632	1.640	0.000	3.033

WALL ANGLE MEASURED FROM NORTH 360.00DEGREES

6	4.951	5.982	1.640	0.256	6.678
7	63.905	23.401	13.096	0.668	68.575
8	133.137	29.558	24.404	0.829	148.678
9	195.098	32.369	34.120	0.879	218.796
10	243.316	33.814	41.569	0.893	270.893
11	273.806	34.526	46.250	0.897	302.825
12	284.230	34.743	47.846	0.897	313.587
13	273.806	34.526	46.250	0.897	302.825
14	243.316	33.814	41.569	0.893	270.893
15	195.098	32.369	34.120	0.879	218.796
16	133.137	29.558	24.404	0.829	148.678
17	63.905	23.401	13.096	0.668	68.575
18	4.951	5.982	1.640	0.256	6.678

SOLA- RADIATION INTENSITIES AND SOLAR HEAT GAINS FOR

AHEMACABAD

HOUR ANGLE AT SUNRISE 99.70 DEGREES

LATITUDE 23.000 JULY DATE15

WALL ANGLE MEASURED FROM NORTH 0.00DEGREES

6	27.791	8.286	3.439	0.678	27.168
7	47.963	18.225	14.693	0.551	49.792
8	37.853	20.748	25.437	0.388	47.480
9	21.609	21.234	34.646	0.213	44.271
10	6.833	21.149	41.701	0.059	45.030
11	0.000	20.984	46.132	0.000	47.652
12	0.000	20.914	47.643	0.000	48.675
13	0.000	20.984	46.132	0.000	47.652
14	6.833	21.149	41.701	0.059	45.030
15	21.609	21.234	34.646	0.213	44.271
16	37.853	20.748	25.437	0.388	47.480
17	47.963	18.225	14.693	0.551	49.792
18	27.791	8.286	3.439	0.678	27.168

WALL ANGLE MEASURED FROM NORTH 45.00DEGREES

6	0.000	4.897	3.439	0.000	5.918
7	0.000	11.686	14.693	0.000	18.729
8	0.000	14.334	25.437	0.000	28.237
9	0.000	15.615	34.646	0.000	35.685
10	0.000	16.292	41.701	0.000	41.175
11	0.000	18.602	46.132	0.000	45.961
12	0.000	21.023	47.643	0.000	48.753
13	45.078	24.157	46.132	0.397	67.794
14	94.300	27.730	41.701	0.686	113.939

15	136.550	31.031	34.646	0.819	158.465
16	163.105	32.665	25.437	0.871	183.291
17	157.885	29.690	14.693	0.889	171.864
18	73.434	13.402	3.439	0.895	77.655
WALL ANGLE MEASURED FROM NORTH			90.00DEGREES		
6	0.000	4.897	3.439	0.000	5.918
7	0.000	11.686	14.693	0.000	18.729
8	0.000	14.334	25.437	0.000	28.237
9	0.000	15.615	34.646	0.000	35.685
10	0.000	16.292	41.701	0.000	41.175
11	0.000	16.631	46.132	0.000	44.562
12	0.000	21.296	47.643	0.000	48.947
13	66.859	25.825	46.132	0.543	87.372
14	126.528	30.758	41.701	0.786	150.925
15	171.501	34.865	34.646	0.866	197.806
16	192.812	36.309	25.437	0.889	215.179
17	175.320	31.992	14.693	0.895	189.999
18	76.060	13.762	3.439	0.896	80.347
WALL ANGLE MEASURED FROM NORTH			135.00DEGREES		
6	0.000	4.897	3.439	0.000	5.918
7	0.000	11.686	14.693	0.000	18.729
8	0.000	14.334	25.437	0.000	28.237
9	0.000	15.615	34.646	0.000	35.685
10	0.000	16.292	41.701	0.000	41.175
11	0.000	18.799	46.132	0.000	46.101
12	4.623	21.577	47.643	0.036	49.314
13	49.474	24.482	46.132	0.429	71.371
14	84.638	26.886	41.701	0.644	103.198
15	105.990	28.006	34.646	0.743	123.231
16	109.573	26.889	25.437	0.781	122.777
17	90.055	21.992	14.693	0.784	96.640
18	34.131	8.867	3.439	0.752	34.402
WALL ANGLE MEASURED FROM NORTH			180.00DEGREES		
6	0.000	4.897	3.439	0.000	5.918
7	0.000	11.686	14.693	0.000	18.729
8	0.000	16.248	25.337	0.000	29.596
9	0.000	18.666	34.646	0.000	37.851
10	0.000	20.337	41.701	0.000	44.047
11	3.109	21.353	46.132	0.022	47.984
12	6.589	21.697	47.643	0.055	49.596
13	3.109	21.353	46.132	0.022	47.984
14	0.000	20.337	41.701	0.000	44.047
15	0.000	18.666	34.646	0.000	37.851
16	0.000	16.248	25.437	0.000	29.596
17	0.000	11.686	14.693	0.000	18.729
18	0.000	4.897	3.439	0.000	5.918
WALL ANGLE MEASURED FROM NORTH			225.00DEGREES		
6	34.131	8.867	3.439	0.752	34.402
7	90.055	21.992	14.693	0.784	96.640
8	109.573	26.889	25.437	0.781	122.777
9	105.990	28.006	34.646	0.743	123.231

10	84.638	26.886	41.701	0.644	103.198
11	49.474	24.482	46.132	0.429	71.371
12	4.695	21.582	47.643	0.037	49.323
13	0.000	18.799	46.132	0.000	46.101
14	0.000	16.292	41.701	0.000	41.175
15	0.000	15.615	34.646	0.000	35.685
16	0.000	14.334	25.437	0.000	28.237
17	0.000	11.686	14.693	0.000	18.729
18	0.000	4.897	3.439	0.000	5.918
WALL ANGLE MEASURED FROM NORTH 270.00DEGREES					
6	76.060	13=762	3.439	0.896	80.347
7	175.320	31.992	14.693	0.895	189.999
8	192.812	36.309	25.437	0.889	215.179
9	171.501	34.865	34.646	0.866	197.806
10	126.528	30.758	41.701	0.786	150.925
11	66.859	25.825	46.132	0.543	87.372
12	0.051	21.302	47.643	0.000	48.951
13	0.000	16.631	46.132	0.000	44.562
14	0.000	16.292	41.701	0.000	41.175
15	0.000	15.615	34.646	0.000	35.685
16	0.000	14.334	25.437	0.000	28.237
17	0.000	11.686	14.693	0.000	18.729
18	0.000	4.897	3.439	0.000	5.918
WALL ANGLE MEASURED FROM NORTH 315.00DEGREES					
6	73.434	13.402	3.439	0.895	77.655
7	157.885	29.69[illegible]	14.693	0.889	171.864
8	163.105	32.665	25.437	0.871	183.291
9	136.550	31.031	34.646	0.819	158.465
10	94.300	27.730	41.701	0.686	113.939
11	45.078	24.157	46.132	0.397	67.794
12	0.000	21.028	47.643	0.000	48.756
13	0.000	18.602	46.132	0.000	45.961
14	0.000	16.292	41.701	0.000	41.175
15	0.000	15.615	34.646	0.000	35.685
16	0.000	14.334	25.437	0.000	28.237
17	0.000	11.686	14.693	0.000	18.729
18	0.000	4.897	3.439	0.000	5.918
WALL ANGLE MEASURED FROM NORTH 360.00DEGREES					
6	11.797	11.129	3.439	0.358	14.568
7	71.393	26.558	14.693	0.706	79.664
8	137.001	32.577	25.437	0.840	156.249
9	195.485	35.489	34.646	0.882	222.282
10	240.980	37.028	41.701	0.894	271.357
11	269.749	37.798	46.132	0.897	301.481
12	279.585	38.034	47.643	0.897	311.641
13	269.749	37.798	46.132	0.897	301.481
14	240.980	37.028	41.701	0.894	271.357
15	195.485	35.489	34.646	0.882	222.282
16	137.001	32.577	25.437	0.840	156.249
17	71.393	26.558	14.693	0.706	79.664
18	11.797	11.129	3.439	0.358	14.568

SOLA- RADIATION INTENSITIES AND SOLAR HEAT GAINS FOR

AMRITSAR

HOUR ANGLE AT SUNRISE 105.29 DEGREES
LATITUDE 31.500 JUNE DATE15

WALL ANGLE MEASURED FROM NORTH 0.00DEGREES

6	43.093	12.727	6.531	0.675	42.767
7	44.489	18.69^	17.035	0.495	47.394
8	23.767	19.865	26.894	0.248	39.099
9	0.000	19.734	35.344	0.000	39.106
10	0.000	19.346	31.820	0.000	43.427
11	0.000	19.046	45.887	0.000	46.102
12	0.000	18.939	47.274	0.000	47.011
13	0.000	19.046	45.887	0.000	46.102
14	0.000	19.346	41.820	0.000	43.427
15	0.000	19.734	35.344	0.000	39.106
16	23.767	19.865	26.894	0.248	39.099
17	44.489	18.69^	17.035	0.495	47.394
18	43.093	12.727	6.531	0.675	42.767

WALL ANGLE MEASURED FROM NORTH 45.0CDEGREES

6	0.000	7.539	6.531	0.000	9.990
7	0.000	12.326	17.035	0.000	20.847
8	0.000	14.439	26.894	0.000	29.346
9	0.000	15.534	35.344	0.000	36.124
10	0.000	16.134	41.820	0.000	41.147
11	0.000	16.441	45.887	0.000	44.253
12	0.000	19.504	47.274	0.000	47.412
13	21.921	22.281	45.887	0.202	52.827
14	73.658	25.680	41.820	0.587	91.168
15	120.568	29.145	35.344	0.782	140.020
16	154.557	31.518	26.894	0.859	174.232
17	162.620	30.516	17.035	0.886	177.824
18	113.520	20.47^	6.531	0.894	120.683

WALL ANGLE MEASURED FROM NORTH 90.0CDEGREES

6	0.000	7.539	6.531	0.000	9.990
7	0.000	12.326	17.035	0.000	20.847
8	0.000	14.439	26.894	0.000	29.346
9	0.000	15.534	35.344	0.000	36.124
10	0.000	16.134	41.*20	0.000	41.147
11	0.000	16.441	45.887	0.000	44.253
12	0.000	21.042	47.274	0.000	48.504
13	66.295	25.468	45.887	0.538	86.332
14	125.683	30.316	41.820	0.783	149.584
15	171.128	34.453	35.344	0.864	197.368
16	194.810	36.284	26.894	0.888	217.796
17	185.490	33.452	17.035	0.894	201.711

18	117.449	20.997	6.531	0.895	124.715

WALL ANGLE MEASURED FROM NORTH 135.00DEGREES

6	0.000	7.539	6.531	0.000	9.990
7	0.000	12.326	17.035	0.000	20.847
8	0.000	14.439	26.894	0.000	29.346
9	0.000	15.534	35.344	0.000	36.124
10	0.000	16.134	41.820	0.000	41.147
11	0.000	19.714	45.887	0.000	46.576
12	28.304	22.823	47.274	0.258	57.064
13	71.834	25.908	45.887	0.570	91.896
14	104.085	28.290	41.820	0.720	124.717
15	121.443	29.230	35.344	0.784	141.030
16	120.946	27.964	26.894	0.804	136.154
17	99.703	23.520	17.035	0.794	107.941
18	52.578	13.58	6.531	0.747	53.564

WALL ANGLE MEASURED FROM NORTH 180.00DEGREES

6	0.000	7.539	6.531	0.000	9.990
7	0.000	12.326	17.035	0.000	20.847
8	0.000	17.082	26.894	0.000	31.223
9	0.619	19.807	35.344	0.002	39.159
10	21.515	21.866	41.820	0.202	49.563
11	35.294	23.179	45.887	0.319	60.281
12	40.084	23.633	47.274	0.355	64.590
13	35.294	23.179	45.887	0.319	60.281
14	21.515	21.866	41C820	0.202	49.563
15	0.619	19.807	35.344	0.002	39.159
16	0.000	17.082	26.894	0.000	31.223
17	0.000	12.326	17.035	0.000	20.847
18	0.000	7.539	6.531	0.000	9.990

WALL ANGLE MEASURED FROM NORTH 225.00DEGREES

6	52.578	13.580	6.531	0.747	53.564
7	99.703	23.520	17.035	0.794	107.941
8	120.946	27.964	26.894	0.804	136.154
9	121.443	29.230	35.344	0.784	141.030
10	104.085	28.290	41.820	0.720	124.717
11	71.834	25.908	45.887	0.570	91.896
12	28.382	22.828	47.274	0.258	57.107
13	0.000	19.714	45.887	0.000	46.576
14	0.000	16.134	41C820	0.000	41.147
15	0.000	15.534	35.344	0.000	36.124
16	0.000	14.439	26.894	0.000	29.346
17	0.000	12.326	17.035	0.000	20.847
18	0.000	7.539	6.531	0.000	9.990

WALL ANGLE MEASURED FROM NORTH 270.00DEGREES

6	117.449	20.997	6.531	0.895	124.715
7	185.490	33.452	17.035	0.894	201.711
8	194.810	36.284	26.*94	0.888	217.796
9	171.128	34.453	35.344	0.864	197.368

10	125.683	30.316	41.820	0.783	149.584
11	66.295	25.468	45.887	0.538	86.332
12	0.055	21.049	47.274	0.000	48.509
13	0.000	16.441	45.887	0.000	44.253
14	0.000	16.134	41.820	0.000	41.147
15	0.000	15.534	35.344	0.000	36.124
16	0.000	14.439	26.894	0.000	29.346
17	0.000	12.326	17.035	0.000	20.847
18	0.000	7.539	6.531	0.000	9.990

WALL ANGLE MEASURED FROM NORTH 315.00DEGREES

6	113.520	20.470	6.531	0.894	120.683
7	162.620	30.516	17.035	0.886	177.824
8	154.557	31.518	26.894	0.859	174.232
9	120.568	29.145	35.344	0.782	140.020
10	73.658	25.680	41.820	0.587	91.168
11	21.921	22.281	45.887	0.202	52.827
12	0.000	19.508	47.274	0.000	47.415
13	0.000	16.441	45.887	0.000	44.253
14	0.000	16.134	41.820	0.000	41.147
15	0.000	15.534	35.344	0.000	36.124
16	0.000	14.439	26.894	0.000	29.346
17	0.000	12.326	17.035	0.000	20.847
18	0.000	7.539	6.531	0.000	9.990

WALL ANGLE MEASURED FROM NORTH 360.00DEGREES

6	26.407	17.133	6.531	0.484	29.577
7	85.555	28.014	17.035	0.746	95.769
8	146.477	32.815	26.894	0.849	166.760
9	200.324	35.305	35.344	0.884	227.209
10	242.128	36.669	41.820	0.894	272.210
11	268.547	37.366	45.887	0.897	299.886
12	277.577	37.581	47.274	0.897	309.229
13	268.547	37.366	45.887	0.897	299.886
14	242.128	36.669	41.820	0.894	272.210
15	200.324	35.305	35.344	0.884	227.209
16	146.477	32.815	26.894	0.849	166.760
17	85.555	28.014	17.035	0.746	95.769
18	26.407	17.133	6.531	0.484	29.577

SOLA- RADIATION INTENSITIES AND SOLAR HEAT GAINS FOR

AMRITSAR

HOUR ANGLE AT SUNRISE 99.34 DEGREES

LATITUDE 31.500 AUGUST DATE15

WALL ANGLE MEASURED FROM NORTH 0.00DEGREES

6	17.050	6.388	2.997	0.505	15.271
7	17.222	14.414	13.841	0.225	23.930
8	0.000	16.161	24.332	0.000	28.750

15	154.192	29.760	33.352	0.843	174.849
16	149.661	28.094	24.332	0.855	165.138
17	117.694	22.402	13.841	0.849	125.669
18	41.336	8.376	2.997	0.822	42.045

WALL ANGLE MEASURED FROM NORTH 180.00DEGREES

6	0.000	4.193	2.997	0.000	5.105
7	0.000	12.578	13.841	0.000	18.757
8	8.321	17.048	24.332	0.084	30.083
9	36.820	20.273	33.352	0.346	50.830
10	60.677	22.66^	40.270	0.506	75.406
11	76.233	24.168	44.617	0.588	93.640
12	81.615	24.687	46.100	0.612	100.226
13	76.233	24.168	44.617	0.588	93.640
14	60.677	22.660	40.270	0.506	75.406
15	36.820	20.273	33.352	0.346	50.830
16	8.321	17.048	24.332	0.084	30.083
17	0.000	12.578	13.841	0.000	18.757
18	0.000	4.193	2.997	0.000	5.105

WALL ANGLE MEASURED FROM NORTH 225.00DEGREES

6	41.336	8.376	2.997	0.822	42.045
7	117.694	22.402	13.841	0.849	125.669
8	149.661	28.094	24.332	0.855	165.138
9	154.192	29.760	33.352	0.843	174.849
10	137.540	28.859	40.270	0.805	159.840
11	103.931	26.319	44.617	0.708	123.902
12	57.756	22.968	46.100	0.477	76.600
13	3.879	19.528	44.617	0.029	45.654
14	0.000	16.529	40.270	0.000	40.327
15	0.000	14.233	33C352	0.000	33.786
16	0.000	13.038	24.332	0.000	26.533
17	0.000	10.559	13.841	0.000	17.324
18	0.000	4.193	2.997	0.000	5.105

WALL ANGLE MEASURED FROM NORTH 270.00DEGREES

6	75.508	12.149	2.997	0.897	78.459
7	183.667	29.779	13.841	0.896	195.520
8	203.331	33.934	24.332	0.891	222.591
9	181.240	32.508	33.352	0.871	204.690
10	133.833	28.523	40.270	0.798	155.596
11	70.747	23.767	44.617	0.558	88.039
12	0.064	19.445	46.100	0.000	46.537
13	0.000	15.179	44.617	0.000	42.455
14	0.000	14.864	40.270	0.000	39.145
15	0.000	14.233	33.352	0.000	33.786
16	0.000	13.038	24.332	0.000	26.533
17	0.000	10.559	13.841	0.000	17.324
18	0.000	4.193	2.997	0.000	5.105

WALL ANGLE MEASURED FROM NORTH 315.00DEGREES

6	65.449	10.920	2.997	0.891	68.216

7	142.050	24.929	13.841	0.878	152.300
8	137.893	26.935	24.332	0.838	151.987
9	102.120	25.061	33.352	0.724	115.453
10	51.729	22.044	40.270	0.447	67.344
11	0.000	19.114	44.617	0.000	45.249
12	0.000	15.276	46.100	0.000	43.576
13	0.000	15.179	44.617	0.000	42.455
14	0.000	14.864	40.270	0.000	39.145
15	0.000	14.233	33.352	0.000	33.786
16	0.000	13.038	24.332	0.000	26.533
17	0.000	10.559	13.841	0.000	17.324
18	0.000	4.193	2.997	0.000	5.105

WALL ANGLE MEASURED FROM NORTH 360.00DEGREES

6	10.448	9.530	2.997	0.335	12.394
7	68.273	23.998	13.841	0.686	73.720
8	132.583	29.631	24.332	0.829	148.268
9	189.999	32.348	33.352	0.877	213.364
10	234.686	33.781	40.270	0.892	261.911
11	262.949	34.498	44.617	0.896	291.723
12	272.613	34.717	46.100	0.896	301.776
13	262.949	34.498	44.617	0.896	291.723
14	234.686	33.781	40.270	0.892	261.911
15	189.999	32.348	33.352	0.877	213.364
16	132.583	29.631	24.332	0.829	148.268
17	68.273	23.998	13.841	0.686	73.720
18	10.448	9.530	2.997	0.335	12.394

SOLA- RADIATION INTENSITIES AND SOLAR HEAT GAINS FOR

DELHI

HOUR ANGLE AT SUNRISE 103.51 DEGREES

LATITUDE 28.500 JUNE DATE15

WALL ANGLE MEASURED FROM NORTH 0.00DEGREES

6	40.418	11.687	5.630	0.687	40.047
7	48.190	18.753	16.425	0.532	50.600
8	31.293	20.315	26.586	0.322	43.388
9	9.863	20.357	35.296	0.093	40.433
10	0.000	20.046	41.970	0.000	44.032
11	0.000	19.775	46.163	0.000	46.815
12	0.000	19.674	47.592	0.000	47.759
13	0.000	19.775	46.163	0.000	46.815
14	0.000	20.046	41.970	0.000	44.032
15	9.863	20.357	35.296	0.093	40.433
16	31.293	20.315	26.586	0.322	43.388
17	48.190	18.753	16.425	0.532	50.600
18	40.418	11.687	5.630	0.687	40.047

WALL ANGLE MEASURED FROM NORTH 45.00DEGREES

6	0.000	6.860	5.630	0.000	8.868
7	0.000	12.146	16.425	0.000	20.285
8	0.000	14.390	26.586	0.000	29.093
9	0.000	15.529	35.296	0.000	36.086
10	0.000	16.147	41.970	0.000	41.263
11	0.000	16.460	46.163	0.000	44.462
12	0.000	20.062	47.592	0.000	48.034
13	31.930	22.972	46.163	0.290	58.349
14	82.702	26.441	41.970	0.633	100.888
15	127.940	29.863	35.296	0.799	148.497
16	159.410	32.016	26.586	0.865	179.440
17	163.317	30.452	16.425	0.887	178.221
18	104.154	18.741	5.630	0.895	110.475

WALL ANGLE MEASURED FROM NORTH 90.00DEGREES

6	0.000	6.860	5.630	0.000	8.868
7	0.000	12.146	16.425	0.000	20.285
8	0.000	14.390	26.586	0.000	29.093
9	0.000	15.529	35.296	0.000	36.086
10	0.000	16.147	41.970	0.000	41.263
11	0.000	16.460	46.163	0.000	44.462
12	0.000	21.070	47.592	0.000	48.750
13	66.372	25.498	46.163	0.538	86.590
14	125.778	30.339	41.970	0.783	149.782
15	171.072	34.442	35.296	0.864	197.278
16	194.146	36.160	26.586	0.888	216.900
17	182.776	32.963	16.425	0.894	198.503
18	106.878	19.107	5.630	0.895	113.268

WALL ANGLE MEASURED FROM NORTH 135.00DEGREES

6	0.000	6.860	5.630	0.000	8.868
7	0.000	12.146	16.425	0.000	20.285
8	0.000	14.390	26.586	0.000	29.093
9	0.000	15.529	35.296	0.000	36.086
10	0.000	16.147	41.970	0.000	41.263
11	0.000	19.233	46.163	0.000	46.431
12	18.026	22.176	47.592	0.165	52.503
13	61.934	25.152	46.163	0.511	82.289
14	95.175	27.511	41.970	0.687	114.696
15	113.992	28.508	35.296	0.764	132.401
16	115.154	27.336	26.586	0.791	129.338
17	95.167	22.875	16.425	0.784	102.555
18	46.994	12.279	5.630	0.741	47.541

WALL ANGLE MEASURED FROM NORTH 180.00DEGREES

6	0.000	6.860	5.630	0.000	8.868
7	0.000	12.146	16.425	0.000	20.285
8	0.000	16.650	26.586	0.000	30.698
9	0.000	19.202	35.296	0.000	38.694
10	8.820	21.079	41.970	0.079	45.461
11	21.216	22.259	46.163	0.195	52.723

12	25.534	22.665	47.592	0.233	55.834
13	21=216	22=259	46.163	0.195	52.723
14	8.820	21.079	41.970	0.079	45.461
15	0.000	19.202	35.296	0.000	38.694
16	0.000	16.650	26.586	0.000	30.698
17	0.000	12.146	16.425	0.000	20.285
18	0.000	6.860	5.630	0.000	8.868

WALL ANGLE MEASURED FROM NORTH 225.00DEGREES

6	46.994	12.279	5.630	0.741	47.541
7	95.167	22.875	16.425	0.784	102.555
8	115.154	27.336	26.586	0.791	129.338
9	113.992	28.508	35.296	0.764	132.401
10	95.175	27.511	41.970	0.687	114.696
11	61.934	25.152	46.163	0.511	82.289
12	18.084	22.180	47.592	0.165	52.526
13	0.000	19.233	46.163	0.000	46.431
14	0.000	16.147	41.970	0.000	41.263
15	0.000	15.529	35.296	0.000	36.086
16	0.000	14.390	26.586	0.000	29.093
17	0.000	12.146	16.425	0.000	20.285
18	0.000	6.860	5C630	0.000	8.868

WALL ANGLE MEASURED FROM NORTH 270.00DEGREES

6	106.878	19.107	5.630	0.895	113.268
7	182.776	32.963	16.425	0.894	198.503
8	194.146	36.160	26.586	0.888	216.900
9	171.072	34.442	35.296	0.864	197.278
10	125.778	30.339	41.970	0.783	149.782
11	66.372	25.498	46.163	0.538	86.590
12	0.041	21.075	47.592	0.000	48.753
13	0.000	16.460	46.163	0.000	44.462
14	0.000	16.147	41.970	0.000	41.263
15	0.000	15.529	35.296	0.000	36.086
16	0.000	14.390	26.586	0.000	29.093
17	0.000	12.146	16.425	0.000	20.285
18	0.000	6.860	5.630	0.000	8.868

WALL ANGLE MEASURED FROM NORTH 315.00DEGREES

6	104.154	18.741	5.630	0.895	110.475
7	163.317	30.452	16.425	0.887	178.221
8	159.410	32.016	26.586	0.865	179.440
9	127.940	29.863	35.296	0.799	148.497
10	82.702	26.441	41.970	0.633	100.888
11	31.930	22.972	46.163	0.290	58.349
12	0.000	20.065	47.592	0.000	48.037
13	0.000	16.460	46.163	0.000	44.462
14	0.000	16.147	41.970	0.000	41.263
15	0.000	15.529	35.296	0.000	36.086
16	0.000	14.390	26.586	0.000	29.093
17	0.000	12.146	16.425	0.000	20.285

18	0.000	6.860	5.630	0.000	8.868

WALL ANGLE MEASURED FROM NORTH 360.00DEGREES

6	21.945	15.591	5.630	0.450	24.944
7	81.893	27.604	16.425	0.736	91.499
8	144.538	32.703	26.586	0.847	164.532
9	2^0.017	35.293	35.296	0.884	226.872
10	243.106	36.697	41.970	0.894	273.245
11	270.341	37.41^	46.163	0.897	301.747
12	279.650	37.629	47.592	0.897	311.366
13	270.341	37.41^	46.163	0.897	301.747
14	233.106	36.697	41.970	0.894	273.245
15	2^0.017	35.293	35.296	0.884	226.872
16	144.538	32.703	26.586	0.847	164.532
17	81.893	27.604	16.425	0.736	91.499

SOLA- RADIATION INTENSITIES AND SOLAR HEAT GAINS FOR

DELHI

18	21.945	15.591	5.630	0.450	24.944

LATITUDE 28.800 AUGUST DATE 1

HOUR ANGLE AT SUNRISE 100.41 DEGREES

WALL ANGLE MEASURED FROM NORTH 0.00DEGREES

6	25.260	7.916	3.772	0.594	23.296
7	31.462	15.709	14.832	0.382	33.708
8	11.048	17.428	25.433	0.113	31.682
9	0.000	17.584	34.542	0.000	37.010
10	0.000	17.378	41.529	0.000	41.824
11	0.000	17.183	45.919	0.000	44.802
12	0.000	17.109	47.416	0.000	45.813
13	0.000	17.183	45.919	0.000	44.802
14	0.000	17.378	41.529	0.000	41.824
15	0.000	17.584	34.542	0.000	37.010
16	11.048	17.428	25.433	0.113	31.682
17	31.462	15.709	14.*32	0.382	33.708
18	25.260	7.916	3.772	0.594	23.296

WALL ANGLE MEASURED FROM NORTH 45.00DEGREES

6	0.000	4.954	3.772	0.000	6.196
7	0.000	10.878	14.832	0.000	18.254
8	0.000	13.215	25.433	0.000	27.440
9	0.000	14.355	34.542	0.000	34.717
10	0.000	14.96^	41.529	0.000	40.107
11	0.000	15.264	45.919	0.000	43.440
12	0.000	17.745	47.416	0.000	46.264
13	15.586	20.291	45.919	0.140	49.189
14	69.437	23.403	41.529	0.556	84.742
15	117.586	26.514	34.542	0.769	133.790
16	151.030	28.410	25.433	0.854	167.190

17	153=737	26.495	14=832	0.884	165.184
18	79.857	13.201	3.772	0.893	83.369

WALL ANGLE MEASURED FROM NORTH 90.00DEGREES

6	0.000	4.954	3.772	0.000	6.196
7	0.000	10.878	14.832	0.000	18.254
8	0.000	13.215	25.433	0.000	27.440
9	0.000	14.355	34.542	0.000	34.717
10	0.000	14.960	41.529	0.000	40.107
11	0.000	15.264	45.919	0.000	43.440
12	0.000	19.542	47.416	0.000	47.540
13	69.914	23.811	45.919	0.551	88.049
14	132.377	28.499	41.529	0.793	154.649
15	179.638	32.455	34.542	0.869	203.656
16	222.540	33.981	25.433	0.890	222.477
17	185.955	30.275	14.832	0.895	198.533
18	87.675	14.160	3.772	0.896	91.317

WALL ANGLE MEASURED FROM NORTH 135.00DEGREES

6	0.000	4.954	3.772	0.000	6.196
7	0.000	10.878	14.832	0.000	18.254
8	0.000	13.215	25.433	0.000	27.440
9	0.000	14.355	34.542	0.000	34.717
10	0.000	14.960	41.529	0.000	40.107
11	0.000	18.629	45.919	0.000	45.829
12	37.169	21.712	47.416	0.326	61.208
13	83.288	24.799	45.919	0.621	101.894
14	117.773	27.220	41.529	0.756	137.882
15	136.460	28.205	34.542	0.813	155.425
16	135.406	26.883	25.433	0.831	149.677
17	109.243	21.918	14.832	0.826	116.364
18	44.134	9.464	3.772	0.795	44.466

WALL ANGLE MEASURED FROM NORTH 180.00DEGREES

6	0.000	4.954	3.772	0.000	6.196
7	0.000	12.354	14.832	0.000	19.302
8	0.000	16.250	25.433	0.000	29.594
9	13.347	19.007	34.542	0.127	39.712
10	34.179	21.023	41.529	0.309	54.990
11	47.873	22.287	45.919	0.410	68.036
12	52.626	22.721	47.416	0.441	73.004
13	47.873	22.287	45.919	0.410	68.036
14	34.179	21.023	41.529	0.309	54.990
15	13.347	19.007	34.542	0.127	39.712
16	0.000	16.250	25.433	0.000	29.594
17	0.000	12.354	14.832	0.000	19.302
18	0.000	4.954	3.772	0.000	6.196

WALL ANGLE MEASURED FROM NORTH 225.00DEGREES

6	44.134	9.464	3.772	0.795	44.466
7	109.243	21.918	14.832	0.826	116.364
8	135.406	26.883	25.433	0.831	149.677

9	136.460	28.205	34.542	0.813	155.425
10	117.773	27.220	41.529	0.756	137.882
11	83.288	24.799	45.919	0.621	101.894
12	37.255	21.717	47.416	0.327	61.265
13	0.000	18.629	45.919	0.000	45.829
14	0.000	14.96[illegible]	41.529	0.000	40.107
15	0.000	14.355	34.542	0.000	34.717
16	0.000	13.215	25.433	0.000	27.440
17	0.000	10.878	14.832	0.000	18.254
18	0.000	4.954	3.772	0.000	6.196

WALL ANGLE MEASURED FROM NORTH 270.00DEGREES

6	87.675	14.160	3.772	0.896	91.317
7	185.955	30.275	14.832	0.895	198.533
8	202.540	33.981	25.433	0.890	222.477
9	179.638	32.455	34.542	0.869	203.656
10	132.377	28.499	41.529	0.793	154.649
11	69.914	23.811	45.919	0.551	88.049
12	0.061	19.549	47.416	0.000	47.545
13	0.000	15.264	45.919	0.000	43.440
14	0.000	14.960	41.529	0.000	40.107
15	0.000	14.355	34.542	0.000	34.717
16	0.000	13.215	25.433	0.000	27.440
17	0.000	10.878	14.*32	0.000	18.254
18	0.000	4.954	3.772	0.000	6.196

WALL ANGLE MEASURED FROM NORTH 315.00DEGREES

6	79.857	13.201	3.772	0.893	83.369
7	153.737	26.495	14.832	0.884	165.184
8	151.030	28.41[illegible]	25.433	0.854	167.190
9	117.586	26.514	34.542	0.769	133.790
10	69.437	23.403	41.529	0.556	84.742
11	15.586	20.291	45.919	0.140	49.189
12	0.000	17.748	47.416	0.000	46.267
13	0.000	15.264	45.919	0.000	43.440
14	0.000	14.960	41.529	0.000	40.107
15	0.000	14.355	34.542	0.000	34.717
16	0.000	13.215	25C433	0.000	27.440
17	0.000	10.878	14.832	0.000	18.254
18	0.000	4.954	3.772	0.000	6.196

WALL ANGLE MEASURED FROM NORTH 360.00DEGREES

6	13.887	11.26[illegible]	3.772	0.372	15.837
7	74.156	24.724	14.832	0.706	80.435
8	139.516	30.035	25.433	0.838	156.274
9	197.657	32.626	34.542	0.881	221.816
10	242.858	34.001	41.529	0.893	270.597
11	271.436	34.691	45.919	0.896	300.555
12	281.205	34.903	47.416	0.897	310.660
13	271.436	34.691	45.919	0.696	300.[illegible]55
14	242.858	34.001	41.529	0.893	270.597

15	197.657	32.626	34.542	0.881	221.816
16	139.516	30.035	25.333	0.838	156.274
17	74.156	24.724	14.832	0.706	80.435
18	13.887	11.260	3.772	0.372	15.837

SOLA- RADIATION INTENSITIES AND SOLAP HEAT GAINS FOR

BOMBA

HOUP ANGLF AT SUNRISE 95.24 DEGREES
LATITUDE 18.990 MAY DATE 1
WALL ANGLE MEASURED FROM NORTH 0.00DEGREES

6	8.088	2.763	1.023	0.546	7.101
7	30.526	14.653	12.546	0.394	31.345
8	20.718	17.664	24.160	0.218	34.220
9	5.333	18.416	34.141	0.045	37.557
10	0.000	18.521	41.793	0.000	42.823
11	0.000	18.474	46.601	0.000	46.203
12	0.000	18.444	48.240	0.000	47.346
13	0.000	18.474	46.601	0.000	46.203
14	0.000	18.521	41.793	0.000	42.823
15	5.333	18.416	34.141	0.045	37.557
16	20.718	17.664	24.160	0.218	34.220
17	30.526	14.653	12.546	0.394	31.345
18	8.088	2.763	1.023	0.546	7.101

WALL ANGLE MEASURED FROM NORTH 45.00DEGREES

6	0.000	1.777	1.023	0.000	1.988
7	0.000	10.099	12.546	0.000	16.078
8	0.000	12.965	24.160	0.000	26.359
9	0.000	14.245	34.141	0.000	34.354
10	0.000	14.894	41.793	0.000	40.248
11	0.000	15.213	46C601	0.000	43.888
12	0.000	18.735	48.240	0.000	47.553
13	38.126	21.571	46.601	0.334	61.144
14	89.660	24.786	41.793	0.656	106.070
15	133.080	27.673	34.141	0.806	151.104
16	158.799	28.820	24.160	0.864	174.878
17	146.813	24.920	12.546	0.885	156.596
18	28.529	4.693	1.023	0.892	29.519

WALL ANGLE MEASURED FROM NORTH 90.00DEGREES

6	0.000	1.777	1.023	0.000	1.988
7	0.000	10.099	12.546	0.000	16.078
8	0.000	12.965	24.160	0.000	26.359
9	0.000	14.245	34.141	0.000	34.354
10	0.000	14.894	41.793	0.000	40.248
11	0.000	15.213	46.601	0.000	43.888
12	0.000	19.482	48.240	0.000	48.083
13	71.485	23.819	46.601	0.558	89.894

14	135.206	28.580	41.793	0.798	157.811
15	182.871	32.533	34.141	0.871	206.687
16	203.858	33.744	24.160	0.891	222.802
17	177.099	28.480	12.546	0.896	187.794
18	32.258	5.148	1.023	0.897	33.306

WALL ANGLE MEASURED FROM NORTH 135.00DEGREES

6	0.000	1.777	1.023	0.000	1.988
7	0.000	10.099	12.546	0.000	16.078
8	0.000	12.965	24.160	0.000	26.359
9	0.000	14.245	34.141	0.000	34.354
10	0.000	14.894	41.793	0.000	40.248
11	0.000	17.538	46.601	0.000	45.539
12	14.647	20.288	48.240	0.130	50.552
13	62.969	23.217	46.601	0.509	81.593
14	101.550	25.722	41.793	0.703	119.325
15	125.539	26.998	34.141	0.789	142.467
16	129.500	25.957	24.160	0.823	142.163
17	103.643	20.478	12.546	0.830	109.424
18	17.091	3.497	1.023	0.813	17.112

WALL ANGLE MEASURED FROM NORTH 180.00DEGREES

6	0.000	1.777	1.023	0.000	1.988
7	0.000	11.425	12.546	0.000	17.019
8	0.000	15.473	24.160	0.000	28.139
9	0.000	17.852	34.141	0.000	36.915
10	8.408	19.410	41.793	0.073	44.068
11	17.566	20.332	46.601	0.158	50.289
12	20.760	20.639	48.240	0.185	52.755
13	17.566	20.332	46.601	0.158	50.289
14	8.408	19.410	41.793	0.073	44.068
15	0.000	17.852	34.141	0.000	36.915
16	0.000	15.473	24.160	0.000	28.139
17	0.000	11.425	12.546	0.000	17.019
18	0.000	1.777	1.023	0.000	1.988

WALL ANGLE MEASURED FROM NORTH 225.00DEGREES

6	17.091	3.497	1.023	0.813	17.112
7	103.643	20.478	12.546	0.830	109.424
8	129.500	25.957	24.160	0.823	142.163
9	125.539	26.998	34.141	0.789	142.467
10	101.550	25.722	41.793	0.703	119.325
11	62.969	23.217	46.601	0.509	81.593
12	14.712	20.291	48.240	0.130	50.572
13	0.000	17.538	46.601	0.000	45.539
14	0.000	14.894	41.793	0.000	40.248
15	0.000	14.245	34.141	0.000	34.354
16	0.000	12.965	24.160	0.000	26.359
17	0.000	10.099	12.546	0.000	16.078
18	0.000	1.777	1.023	0.000	1.988

WALL ANGLE MEASURED FROM NORTH 270.00DEGREES

6	32.258	5.148	1.023	0.897	33.306
7	177.099	28.480	12.546	0.896	187.794
8	2[illegible]3.858	33.744	24.160	0.891	222.802
9	182.871	32.533	34.141	0.871	206.687
10	135.206	28.580	41.793	0.798	157.811
11	71.485	23.819	46.601	0.558	89.894
12	0.046	19.487	48.240	0.000	48.086
13	0.000	15.213	46.601	0.000	43.888
14	0.000	14.894	41.793	0.000	40.248
15	0.000	14.245	34.141	0.000	34.354
16	0.000	12.965	24.160	0.000	26.359
17	0.000	10.099	12.546	0.000	16.078
18	0.000	1.777	1.[illegible]23	0.000	1.988

WALL ANGLE MEASURED FROM NORTH 315.00DEGREES

6	28.529	4.693	1.023	0.892	29.519
7	146.813	24.920	12.546	0.885	156.596
8	158.799	28.820	24.160	0.864	174.878
9	133.080	27.673	34.141	0.806	151.104
10	89.660	24.786	41.793	0.656	106.070
11	38.126	21.571	46.601	0.334	61.144
12	0.000	18.739	48.240	0.000	47.555
13	0.000	15.213	46.601	0.000	43.888
14	0.000	14.894	41.793	0.000	40.248
15	0.000	14.245	34.141	0.000	34.354
16	0.000	12.965	24.160	0.000	26.359
17	0.000	10.099	12.546	0.000	16.078
18	0.000	1.777	1.023	0.000	1.988

WALL ANGLE MEASURED FROM NORTH 360.00DEGREES

6	2.783	4.038	1.023	0.214	4.190
7	60.690	22.952	12.546	0.655	64.965
8	131.601	29.467	24.160	0.827	146.900
9	195.232	32.374	34.141	0.880	218.942
10	244.769	33.850	41.793	0.894	272.431
11	276.097	34.575	46.601	0.897	305.196
12	286.806	34.794	48.240	0.897	316.237
13	276.097	34.575	46.601	0.897	305.196
14	244.769	33.85[illegible]	41.793	0.894	272.431
15	195.232	32.374	34.141	0.880	218.942
16	131.601	29.467	24.160	0.827	146.900
17	60.690	22.952	12.546	0.655	64.965
18	2.783	4.038	1.023	0.214	4.190

SOLA- RADIATION INTENSITIES AND SOLAR HEAT GAINS FOR

BOMBAY

HOUR ANGLE AT SUNRISE 95.53 DEGREES

LATITUDE 19.990 AUGUST DATE15

WALL ANGLE MEASURED FROM N6RTH 0.00DEGREES

6	8.495	2.943	1.110	0.543	7.488
7	29.190	14.591	12.556	0.382	30.417
8	18.250	17.572	24.113	0.194	33.131
9	1.842	18.306	34.055	0.012	37.198
10	0.000	18.399	41.679	0.000	42.655
11	0.000	18.344	46.469	0.000	46.018
12	0.000	18.312	48.103	0.000	47.155
13	0.000	18.344	46.469	0.000	46.018
14	0.000	18.399	41.679	0.000	42.655
15	1.842	18.306	34.055	0.012	37.198
16	18.250	17.572	24.113	0.194	33.131
17	29.190	14.591	12.556	0.382	30.417
18	8.495	2.943	1.110	0.543	7.488

WALL ANGLE MEASURED FROM NORTH 45.00DEGREES

6	0.000	1.895	1.110	0.000	2.134
7	0.000	10.106	12.556	0.000	16.090
8	0.000	13.001	24.113	0.000	26.351
9	0.000	14.306	34.055	0.000	34.336
10	0.000	14.972	41.679	0.000	40.222
11	0.000	15.299	46.469	0.000	43.856
12	0.000	18.668	48.103	0.000	47.408
13	34.577	21.475	46.469	0.306	58.836
14	86.328	24.678	41.679	0.642	102.556
15	130.115	27.570	34.055	0.800	147.911
16	156.278	28.729	24.113	0.863	172.336
17	144.936	24.850	12.556	0.885	154.822
18	30.141	5.002	1.110	0.892	31.236

WALL ANGLE MEASURED FROM NORTH 90.00DEGREES

6	0.000	1.895	1.110	0.000	2.134
7	0.000	10.106	12.556	0.000	16.090
8	0.000	13.001	24.113	0.000	26.351
9	0.000	14.306	34.055	0.000	34.336
10	0.000	14.972	41.679	0.000	40.222
11	0.000	15.299	46.469	0.000	43.856
12	0.000	19.595	48.103	0.000	48.066
13	71.306	23.954	46.469	0.558	89.799
14	134.806	28.730	41.679	0.798	157.519
15	182.168	32.675	34.055	0.871	206.116
16	202.760	33.839	24.113	0.891	221.858
17	175.780	28.501	12.556	0.896	186.634
18	34.131	5.492	1.110	0.897	35.291

WALL ANGLE MEASURED FROM NORTH 135.00DEGREES

6	0.000	1.895	1.110	0.000	2.134
7	0.000	10.106	12.556	0.000	16.090
8	0.000	13.001	24.113	0.000	26.351
9	0.000	14.306	34.055	0.000	34.336
10	0.000	14.972	41.679	0.000	40.222
11	0.000	17.788	46.469	0.000	45.623

18	0.000	1.895	1.110	0.000	2.134

WALL ANGLE MEASURED FROM NORTH 315.00DEGREES

6	30.141	5.002	1.110	0.892	31.236
7	144.936	24.850	12.556	0.885	154.822
8	156.278	28.729	24.113	0.863	172.336
9	130.115	27.57	34.055	0.800	147.911
10	86.328	24.678	41.679	0.642	102.556
11	34.577	21.475	46.469	0.306	58.836
12	0.000	18.672	48.103	0.000	47.410
13	0.000	15.299	46.469	0.000	43.856
14	0.000	14.972	41.679	0.000	40.222
15	0.000	14.306	34.055	0.000	34.336
16	0.000	13.001	24.113	0.000	26.351
17	0.000	10.106	12.556	0.000	16.090
18	0.000	1.895	1.110	0.000	2.134

WALL ANGLE MEASURED FROM NORTH 360.00DEGREES

6	3.090	4.308	1.110	0.225	4.540
7	60.738	22.967	12.556	0.658	65.211
8	131.207	29.548	24.113	0.828	146.676
9	194.517	32.514	34.055	0.880	218.357
10	243.832	34.026	41.679	0.894	271.629
11	275.026	34.770	46.469	0.897	304.276
12	285.692	34.996	48.103	0.897	315.279
13	275.026	34.770	46.469	0.897	304.276
14	243.832	34.026	41.679	0.894	271.629
15	194.517	32.514	34.055	0.880	218.357
16	131.207	29.548	24.113	0.828	146.676
17	60.738	22.967	12.556	0.658	65.211
18	3.090	4.308	1.110	0.225	4.540

SOLAR RADIATION INTENSITIES AND SOLAR HEAT GAINS FOR

MADRAS

HOUR ANGLE AT SUNRISE 95.38 DEGREES

LATITUDE 13.100 JUNE DATE 1

WALL ANGLE MEASURED FROM NORTH 0.00DEGREES

6	11.172	3.128	1.007	0.704	10.802
7	56.131	17.618	12.304	0.642	57.304
8	60.964	21.898	23.674	0.572	67.213
9	55.982	23.285	33.427	0.500	68.246
10	49.572	23.719	40.897	0.437	67.548
11	44.841	23.827	45.589	0.394	66.969
12	43.133	23.842	47.189	0.379	66.787
13	44.841	23.827	45.589	0.394	66.969
14	49.572	23.719	40.897	0.437	67.548
15	55.982	23.285	33.427	0.500	68.246
16	60.964	21.898	23.674	0.572	67.213

17	56.131	17.618	12.304	0.642	57.304
18	11.172	3.128	1.007	0.704	10.802

WALL ANGLE MEASURED FROM NORTH 45.00DEGREES

6	0.000	1.809	1.007	0.000	1.999
7	0.000	10.687	12.304	0.000	16.324
8	0.000	13.880	23.674	0.000	26.664
9	0.000	15.322	33.427	0.000	34.612
10	0.000	17.714	40.897	0.000	41.614
11	0.000	20.023	45.589	0.000	46.585
12	30.458	22.961	47.189	0.276	58.225
13	78.981	26.463	45.589	0.608	99.160
14	124.366	30.102	40.897	0.781	147.528
15	160.104	33.013	33.427	0.855	184.008
16	176.823	33.591	23.674	0.883	196.724
17	154.523	28.176	12.304	0.892	166.621
18	28.026	5.018	1.007	0.895	29.368

WALL ANGLE MEASURED FROM NORTH 90.00DEGREES

6	0.000	1.809	1.007	0.000	1.999
7	0.000	10.687	12.304	0.000	16.324
8	0.000	13.880	23.674	0.000	26.664
9	0.000	15.322	33.327	0.000	34.612
10	0.000	16.058	40.897	0.000	40.438
11	0.000	16.420	45.589	0.000	44.026
12	0.000	21.035	47.189	0.000	48.439
13	66.855	25.486	45.589	0.542	86.689
14	126.307	30.291	40.897	0.786	149.769
15	170.439	34.170	33.427	0.865	195.472
16	189.101	35.110	23.674	0.888	209.748
17	162.397	29.214	12.304	0.895	174.757
18	28.463	5.077	1.007	0.896	29.815

WALL ANGLE MEASURED FROM NORTH 135.00DEGREES

6	0.000	1.809	1.007	0.000	1.999
7	0.000	10.687	12.304	0.000	16.324
8	0.000	13.880	23.674	0.000	26.664
9	0.000	15.322	33.427	0.000	34.612
10	0.000	16.058	40.897	0.000	40.438
11	0.000	16.420	45.589	0.000	44.026
12	0.000	19.389	47.189	0.000	47.270
13	15.566	21.846	45.589	0.143	50.101
14	54.260	24.068	40.897	0.470	71.641
15	80.933	25.297	33.427	0.645	93.867
16	90.606	24.434	23.674	0.724	99.773
17	75.142	19.309	12.304	0.750	78.793
18	12.226	3.223	1.007	0.736	12.006

WALL ANGLE MEASURED FROM NORTH 180.00DEGREES

6	0.000	1.809	1.007	0.000	1.999
7	0.000	10.687	12.304	0.000	16.324
8	0.000	13.880	23.674	0.000	26.664

9	0.000	15.322	33.427	0.000	34.612
10	0.000	17.913	40.897	0.000	41.755
11	0.000	18.575	45.589	0.000	45.557
12	0.000	18.791	47.189	0.000	46.845
13	0.000	18.575	45.589	0.000	45.557
14	0.000	17.913	40.897	0.000	41.755
15	0.000	15.322	33.427	0.000	34.612
16	0.000	13.880	23.674	0.000	26.664
17	0.000	10.687	12.304	0.000	16.324
18	0.000	1.809	1.007	0.000	1.999

WALL ANGLE MEASURED FROM NORTH 225.00DEGREES

6	12.226	3.223	1.007	0.736	12.006
7	75.142	19.309	12.304	0.750	78.793
8	90.606	24.434	23.674	0.724	99.773
9	80.933	25.297	33.427	0.645	93.867
10	54.260	24.068	40.897	0.470	71.641
11	15.566	21.846	45.589	0.143	50.101
12	0.000	19.393	47.189	0.000	47.273
13	0.000	16.420	45.589	0.000	44.026
14	0.000	16.058	40.897	0.000	40.438
15	0.000	15.322	33.427	0.000	34.612
16	0.000	13.880	23.674	0.000	26.664
17	0.000	10.687	12.304	0.000	16.324
18	0.000	1.809	1.007	0.000	1.999

WALL ANGLE MEASURED FROM NORTH 270.00DEGREES

6	28.463	5.077	1.007	0.896	29.815
7	162.397	29.214	12.304	0.895	174.757
8	189.101	35.110	23.674	0.888	209.748
9	170.439	34.170	33.427	0.865	195.472
10	126.307	30.291	40.897	0.786	149.769
11	66.855	25.486	45.589	0.542	86.689
12	0.059	21.042	47.189	0.000	48.443
13	0.000	16.420	45.589	0.000	44.026
14	0.000	16.058	40.897	0.000	40.438
15	0.000	15.322	33.427	0.000	34.612
16	0.000	13.880	23.674	0.000	26.664
17	0.000	10.687	12.304	0.000	16.324
18	0.000	1.809	1.007	0.000	1.999

WALL ANGLE MEASURED FROM NORTH 315.00DEGREES

6	28.026	5.018	1.007	0.895	29.368
7	154.523	28.176	12.304	0.892	166.621
8	176.823	33.591	23.674	0.883	196.724
9	160.104	33.013	33.427	0.855	184.008
10	124.366	30.102	40.897	0.781	147.528
11	78.981	26.463	45.589	0.608	99.160
12	30.542	22.966	47.189	0.277	58.274
13	0.000	20.023	45.589	0.000	46.585
14	0.000	17.714	40.897	0.000	41.614

15	0.000	15.322	33.427	0.000	34.612
16	0.000	13.880	23.674	0.000	26.664
17	0.000	10.687	12.304	0.000	16.324
18	0.000	1.809	1.007	0.000	1.999

WALL ANGLE MEASURED FROM NORTH 360.00DEGREES

6	2.600	4.112	1.007	0.218	4.200
7	57.739	24.290	12.304	0.653	63.710
8	126.281	31.546	23.674	0.825	143.406
9	188.020	34.823	33.427	0.879	213.650
10	236.152	36.496	40.397	0.893	265.872
11	266.608	37.318	45.589	0.896	297.873
12	277.022	37.568	47.189	0.897	308.656
13	266.608	37.318	45.589	0.896	297.873
14	236.152	36.496	40.397	0.893	265.872
15	188.020	34.823	33.427	0.879	213.650
16	126.281	31.546	23.674	0.825	143.406
17	57.739	24.290	12.304	0.653	63.710
18	2.600	4.112	1.007	0.218	4.200

AHMEDABAD CITY

Date	Probability	Elements: Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st March	99.5	97.6	22.5	67.5	12.5
	99.0	96.8	23.4	66.7	12.9
	97.5	95.7	24.6	65.8	13.3
	95.0	94.9	25.5	65.1	13.7
	90.0	94.1	26.5	64.4	14.0
	75.0	92.9	27.9	63.3	14.6
15th March	99.5	100.7	23.2	67.4	9.0
	99.0	100.1	23.8	67.0	9.5
	97.5	99.3	24.5	66.6	10.1
	95.0	98.6	25.1	66.2	10.5
	90.0	98.0	25.7	65.8	11.0
	75.0	97.0	26.7	65.2	11.7
1st April	99.5	103.1	22.2	70.8	9.0
	99.0	102.4	22.8	70.4	9.8
	97.5	101.6	23.7	69.9	10.7
	95.0	101.0	24.3	69.5	11.4
	90.0	100.3	25.0	69.1	12.1
	75.0	99.4	25.9	68.5	13.1
15th April	99.5	107.8	17.6	74.8	6.9
	99.0	106.7	19.0	73.7	8.0
	97.5	105.3	20.6	72.2	9.3
	95.0	104.3	21.8	71.2	10.3
	90.0	103.3	23.0	70.3	11.3
	75.0	101.9	24.7	68.7	12.7
1st May	99.5	110.0	22.8	84.3	9.4
	99.0	109.4	23.5	82.5	10.4
	97.5	108.8	24.4	80.5	11.6
	95.0	108.3	24.9	79.1	12.4
	90.0	107.9	25.4	77.9	13.2
	75.0	107.3	26.0	76.2	14.2

Contd...

AHMEDABAD CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
15th May	99.5	110.4	20.8	78.3	7.0
	99.0	109.8	21.3	77.8	7.8
	97.5	109.0	21.9	77.2	8.8
	95.0	108.4	22.4	76.8	9.6
	90.0	107.8	22.9	76.3	10.4
	75.0	106.9	23.6	75.6	11.6
1st June	99.5	105.9	16.6	79.4	1.7
	99.0	105.5	17.1	79.3	2.4
	97.5	105.0	17.7	79.1	3.4
	95.0	104.6	18.2	78.9	4.1
	90.0	104.2	18.7	78.3	4.8
	75.0	103.6	19.5	78.6	5.9
15th June	99.5	104.2	14.6	80.2	2.4
	99.0	103.6	15.2	80.0	3.0
	97.5	103.0	15.9	79.7	3.7
	95.0	102.5	16.4	79.5	4.2
	90.0	102.0	16.9	79.3	4.7
	75.0	101.4	17.6	79.0	5.5
1st July	99.5	100.0	5.3	83.1	2.1
	99.0	98.8	6.3	82.8	2.5
	97.5	97.2	7.5	82.4	3.0
	95.0	96.1	8.4	82.0	3.4
	90.0	94.9	9.3	81.7	3.8
	75.0	93.2	10.6	81.2	4.3
15th July	99.5	92.7	4.7	82.1	1.0
	99.0	92.0	5.5	81.6	1.8
	97.5	91.2	6.5	81.1	2.7
	95.0	90.7	7.1	80.8	3.3
	90.0	90.2	7.8	80.4	3.9
	75.0	89.4	8.7	79.9	4.8

Contd...

AHMEDABAD CITY

Date	Probability	Elements: Dry bulb temperature	Elements: Dry bulb temperature range	Elements: Wet bulb temperature	Elements: Wet bulb temperature range
1st August	99.5	93.0	6.4	81.6	2.5
	99.0	92.3	7.0	81.3	2.8
	97.5	91.4	7.7	80.9	3.1
	95.0	90.8	8.2	80.6	3.3
	90.0	90.2	8.8	80.3	3.6
	75.0	89.2	9.6	79.9	3.9
15th August	99.5	92.5	5.9	81.0	2.4
	99.0	91.8	6.4	80.6	2.6
	97.5	90.9	7.1	80.2	2.9
	95.0	90.2	7.6	79.8	3.1
	90.0	89.6	8.0	79.5	3.3
	75.0	88.6	8.7	79.0	3.6
1st September	99.5	95.8	5.7	81.7	2.6
	99.0	94.7	6.7	81.2	3.0
	97.5	93.4	7.9	80.6	3.3
	95.0	92.5	8.8	80.1	3.6
	90.0	91.6	9.6	79.7	3.9
	75.0	90.2	10.9	79.0	4.3
15th September	99.5	92.1	8.2	80.0	3.2
	99.0	91.5	8.7	79.7	3.6
	97.5	90.8	9.4	79.3	4.1
	95.0	90.2	9.8	79.0	4.5
	90.0	89.7	10.3	78.3	4.9
	75.0	88.9	11.0	78.3	5.5

ALLAHABAD CITY

Date	Probability	Elements: Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st March	99.5	91.1	21.5	64.6	5.0
	99.0	90.2	22.5	63.8	5.5
	97.5	89.1	23.5	62.9	6.2
	95.0	88.3	24.3	62.2	6.7
	90.0	87.6	25.0	61.5	7.1
	75.0	86.6	26.0	60.7	7.7
15th March	99.5	98.8	17.5	68.8	4.4
	99.0	98.0	18.9	68.3	5.2
	97.5	97.1	20.5	67.6	6.1
	95.0	96.4	21.7	67.2	6.7
	90.0	95.7	22.8	66.7	7.4
	75.0	94.7	24.5	66.1	8.3
1st April	99.5	103.6	19.4	70.2	6.0
	99.0	102.7	20.3	69.8	6.9
	97.5	101.6	21.3	69.3	8.0
	95.0	100.8	22.0	68.9	8.8
	90.0	100.0	22.7	68.5	9.6
	75.0	98.8	23.7	67.9	10.7
15th April	99.5	108.5	24.6	70.9	9.5
	99.0	107.9	25.0	70.3	9.8
	97.5	107.1	25.6	69.5	10.1
	95.0	106.4	26.0	68.9	10.4
	90.0	105.8	26.5	68.3	10.7
	75.0	104.8	27.2	67.4	11.1
1st May	99.5	108.5	20.6	77.0	8.3
	99.0	108.1	21.2	76.3	8.7
	97.5	107.6	22.0	75.4	9.2
	95.0	107.2	22.5	74.7	9.6
	90.0	106.7	23.2	74.0	10.0
	75.0	106.0	24.1	73.8	10.7

Contd...

ALLAHABAD CITY

Date	Probability	Elements: Dry bulb temperature	Elements: Dry bulb temperature range	Elements: Wet bulb temperature	Elements: Wet bulb temperature range
15th May	99.5	111.5	15.4	74.9	8.3
	99.0	110.6	16.4	74.5	8.8
	97.5	109.6	17.6	74.0	9.5
	95.0	108.7	18.6	73.7	10.0
	90.0	107.9	19.5	73.3	10.6
	75.0	106.6	21!0	72.8	11.4
1st June	99.5	114.9	9.2	80.9	5.2
	99.0	113.7	10.7	79.9	6.0
	97.5	112.0	12.5	78.6	7.0
	95.0	110.8	13.9	77.7	7.7
	90.0	109.6	15.3	76.7	8.5
	75.0	107.7	17.4	75.3	9.6
15th June	99.5	111.9	12.5	81.2	4.4
	99.0	110.9	13.2	80.8	4.9
	97.5	109.7	14.1	80.2	5.6
	95.0	108.7	14.8	79.9	6.1
	90.0	107.8	15.4	79.5	6.6
	75.0	106.3	16.5	78.9	7.4
1st July	99.5	101.3	8.1	84.7	3.8
	99.0	100.4	8.6	84.3	4.2
	97.5	99.3	9.3	83.7	4.6
	95.0	98.4	9.8	83.3	4.9
	90.0	97.5	10.4	82.8	5.2
	75.0	96.1	11.2	82.2	5.8
15th July	99.5	97.0	7.7	84.8	4.4
	99.0	96.2	8.2	84.5	4.6
	97.5	95,1	8.9	84.0	4.8
	95.0	94,3	9.4	83.7	5.0
	90.0	93.5	9.9	83.4	5.2
	75.0	92.3	10.7	82.9	5.5

Contd...

ALLAHABAD CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bu temper ture range
1st August	99.5	92.7	7.2	86.1	3.2
	99.0	92.4	7.6	85.7	3.6
	97.5	91.9	8.1	85.3	4.1
	95.0	91.6	8.5	84.9	4.5
	90.0	91.3	8.8	84.6	4.9
	75.0	90.8	9.4	84.0	5.5
15th August	99.5	91.5	6.8	83.7	2.9
	99.0	91.1	7.1	83.5	3.2
	97.5	90.7	7.4	83.3	3.5
	95.0	90.3	7.7	83.1	3.8
	90.0	90.0	7.9	82.9	4.0
	75.0	89.5	8.3	82.6	4.4
1st September	99.5	94.2	4.4	84.6	1.4
	99.0	93.4	5.2	84.1	2.3
	97.5	92.3	6.1	83.4	3.2
	95.0	91.6	6.7	83.0	3.9
	90.0	90.9	7.4	82.6	4.6
	75.0	89.9	8.3	82.0	5.5
15th September	99.5	92.9	9.1	82.4	4.6
	99.0	92.5	9.5	82.2	4.8
	97.5	92.0	10.0	82.0	5.1
	95.0	91.6	10.4	81.8	5.3
	90.0	91.2	10.8	81.6	5.5
	75.0	90.6	11.4	81.3	5.9

AMRITSAR CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st March	99.5	77.0	185.1	194.3	35.9
	99.0	77.0	79.1	126.4	12.2
	97.5	77.0	15.4	85.6	2.1
	95.0	77.0	5.9	72.0	6.9
	90.0	77.0	16.7	65.1	9.3
	75.0	77.0	23.6	60.6	10.9
15th March	99.5	88.5	16.1	68.1	6.6
	99.0	87.5	17.0	67.5	7.2
	97.5	86.2	18.1	66.9	8.0
	95.0	85.2	18.9	66.4	8.6
	90.0	84.3	19.7	65.9	9.2
	75.0	82.9	20.9	65.2	10.0
1st April	99.5	89.3	22.5	68.5	6.0
	99.0	88.7	23.0	67.6	6.4
	97.5	88.0	23.7	66.5	6.9
	95.0	87.5	24.2	65.7	7.2
	90.0	87.0	24.7	64.9	7.6
	75.0	86.2	25.5	63.7	8.1
15th April	99.5	105.3	17.7	75.2	9.0
	99.0	103.3	19.1	73.4	9.2
	97.5	100.8	20.8	71.3	9.4
	95.0	99.1	21.9	69.8	9.6
	90.0	97.4	23.1	68.3	9.7
	75.0	95.0	24.7	66.3	9.9
1st May	99.5	107.1	20.4	68.4	3.4
	99.0	105.8	21.7	68.1	4.2
	97.5	104.3	23.3	67.7	5.1
	95.0	103.1	24.4	67.4	5.7
	90.0	102.0	25.6	67.1	6.4
	75.0	100.4	27.2	66.7	7.3

contd..

AMRITSAR CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
6					
15th May	99.5	103.7	18.1	73.2	5.0
	99.0	102.7	19.0	72.4	5.5
	97.5	101.6	20.2	71.5	6.2
	95.0	100.7	21.0	70.8	6.7
	90.0	99.8	21.9	70.1	7.2
	75.0	98.5	23.1	69.0	7.9
15th June	99.5	110.1	21.4	77.5	6.4
	99.0	109.3	21.9	77.0	6.8
	97.5	108.3	22.6	76.3	7.3
	95.0	107.6	23.1	75.8	7.7
	90.0	106.8	23.6	75.3	8.0
	75.0	105.7	24.4	74.5	8.6
1st July	99.5	114.2	5.0	82.6	2.1
	99.0	111.3	6.9	81.9	3.0
	97.5	107.8	9.1	81.1	4.2
	95.0	105.4	10.6	80.5	4.9
	90.0	103.1	12.1	79.9	5.7
	75.0	99.8	14.2	79.2	6.8
15th July	99.5	104.5	3.5	86.2	2.1
	99.0	102.4	4.8	85.2	2.7
	97.5	99.8	6.3	84.1	3.4
	95.0	98.0	7.4	83.3	3.8
	90.0	96.2	8.4	82.5	4.3
	75.0	99.5	9.9	81.4	5.0
1st August	99.5	99.4	8.7	85.6	3.3
	99.0	98.3	9.1	85.1	3.6
	97.5	97.0	9.7	84.5	4.1
	95.0	95.9	10.2	84.0	4.4
	90.0	94.9	10.6	83.5	4.8
	75.0	93.4	11.2	82.8	5.3

contd..

AMRITSAR CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
15th August	99.5	94.5	9.1	86.0	2.5
	99.0	94.1	9.5	85.6	3.1
	97.5	93.6	10.0	85.1	3.7
	95.0	93.2	10.4	84.8	4.2
	90.0	92.8	10.8	84.4	4.7
	75.0	92.2	11.4	83.9	5.5
1st September	99.5	95.4	7.6	84.2	3.0
	99.0	94.6	8.2	83.8	3.5
	97.5	93.6	8.9	83.3	4.1
	95.0	92.9	9.4	82.9	4.6
	90.0	92.2	10.0	82.5	5.1
	75.0	91.1	10.8	82.0	5.8
15th September	99.5	96.0	10.1	83.4	1.4
	99.0	95.3	11.1	82.8	2.5
	97.5	94.5	12.2	82.0	3.8
	95.0	93.9	13.1	81.5	4.7
	90.0	93.4	13.9	81.0	5.6
	75.0	92.6	15.0	80.3	6.9

AURANGABAD CITY

Date	Probability	Elements: Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st March	99.5	94.5	22.4	69.4	13.1
	99.0	93.9	23.3	68.9	13.6
	97.5	93.2	24.4	68.2	14.3
	95.0	92.6	25.3	67.7	14.9
	90.0	92.0	26.3	67.1	15.4
	75.0	91.1	27.7	66.3	16.2
15th March	99.5	98.0	21.6	74.4	10.4
	99.0	97.6	22.5	73.5	11.2
	97.5	97.1	23.7	72.4	12.2
	95.0	96.8	24.6	71.6	12.9
	90.0	96.4	25.6	70.7	13.7
	75.0	95.8	27.0	69.4	14.9
1st April	99.5	101.7	19.4	79.8	8.5
	99.0	100.9	20.5	78.8	10.2
	97.5	99.8	21.9	77.6	12.2
	95.0	99.1	22.8	76.7	13.7
	90.0	98.4	23.8	75.9	15.0
	75.0	97.4	25.1	74.8	17.0
15th April	99.5	105.8	10.6	80.8	2.0
	99.0	104.2	13.3	78.5	4.7
	97.5	102.4	16.2	75.3	6.8
	95.0	101.3	18.2	74.0	8.2
	90.0	100.2	20.0	72.4	9.4
	75.0	98.7	22.5	70.2	11.1
1st May	99.5	107.4	16.1	82.5	6.8
	99.0	106.3	17.1	81.6	7.2
	97.5	105.0	18.2	80.5	8.1
	95.0	104.1	19.1	79.7	8.9
	90.0	103.1	19.9	78.8	9.6
	75.0	101.8	21.1	77.7	10.6

Contd...

AURANGABAD CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
15th May	99.5	109.7	3.8	88.1	1.7
	99.0	106.0	6.9	85.2	3.8
	97.5	102.2	10.2	82.3	5.9
	95.0	99.8	12.2	80.4	7.2
	90.0	97.8	14.0	78.9	8.3
	75.0	95.4	16.1	77.0	9.7
1st June	99.5	103.1	15.4	79.5	3.5
	99.0	102.3	16.1	79.0	4.2
	97.5	101.3	17.0	78.4	5.0
	95.0	100.5	17.7	77.9	5.6
	90.0	99.7	18.3	77.4	6.2
	75.0	98.5	19.4	76.7	7.2
15th June	99.5	99.8	15.3	78.7	2.2
	99.0	98.9	16.0	78.2	3.0
	97.5	97.8	16.8	77.6	4.0
	95.0	97.0	17.4	77.2	4.7
	90.0	96.2	17.9	76.7	5.4
	75.0	95.0	18.8	76.1	6.4
1st July	99.5	91.8	8.5	76.5	2.7
	99.0	91.0	9.3	76.3	3.1
	97.5	90.0	10.2	75.9	3.6
	95.0	89.2	10.9	75.6	4.0
	90.0	88.4	11.6	75.4	4.4
	75.0	87.3	12.6	75.0	5.0
15th July	99.5	89.1	9.6	78.0	2.8
	99.0	88.6	10.1	77.5	3.3
	97.5	87.9	10.7	76.9	3.9
	95.0	87.4	11.1	76.4	4.4
	90.0	86.9	11.6	75.9	4.9
	75.0	86.1	12.3	75.2	5.7

Contd...

AURANGABAD CITY

Date	Probability	Elements: Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st August	99.5	84.2	4.3	75.1	3.4
	99.0	83.6	4.8	74.9	3.6
	97.5	82.8	5.6	74.6	3.8
	95.0	82.2	6.1	74.5	4.0
	90.0	81.7	6.6	74.3	4.2
	75.0	80.8	7.4	74.0	4.5
15th August	99.5	88.7	1.8	77.7	1.9
	99.0	87.5	3.0	77.1	2.4
	97.5	86.1	4.5	76.3	3.1
	95.0	85.1	5.6	75.7	3.6
	90.0	84.1	6.7	75.1	4.1
	75.0	82.6	8.3	74.3	4.7
1st September	99.5	86.6	3.9	76.4	2.8
	99.0	85.7	4.8	75.9	3.2
	97.5	84.6	5.9	75.4	3.6
	95.0	83.8	6.6	75.0	4.0
	90.0	83.1	7.4	74.5	4.3
	75.0	81.9	8.5	74.0	4.8
15th September	99.5	86.4	10.2	75.5	3.7
	99.0	86.1	10.7	75.2	4.0
	97.5	85.6	11.3	74.7	4.4
	95.0	85.3	11.8	74.3	4.6
	90.0	84.9	12.3	73.8	4.9
	75.0	84.4	13.1	73.3	5.4

BANGALORE CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st March	99.5	90.2	15.9	70.0	3.5
	99.0	89.8	16.5	69.3	4.0
	97.5	89.3	17.3	68.5	4.6
	95.0	89.0	17.9	67.9	5.0
	90.0	88.6	18.5	67.3	5.5
	75.0	88.0	19.4	66.4	6.1
15th March	99.5	88.9	16.3	68.9	3.7
	99.0	88.7	16.9	68.2	4.2
	97.5	88.4	17.7	67.3	4.8
	95.0	88.2	18.3	66.6	5.3
	90.0	87.9	18.9	65.9	5.8
	75.0	87.6	19.8	64.8	6.5
1st April	99.5	92.1	17.4	72.2	5.7
	99.0	91.8	17.7	71.8	6.2
	97.5	91.4	18.1	71.2	6.8
	95.0	91.1	18.4	70.7	7.3
	90.0	90.7	18.7	70.2	7.8
	75.0	90.3	19.2	69.5	8.5
15th April	99.5	93.4	14.6	73.0	3.5
	99.0	92.9	15.0	72.7	4.0
	97.5	92.3	15.5	72.4	4.7
	95.0	91.9	15.9	72.1	5.2
	90.0	91.4	16.3	71.9	5.7
	75.0	90.6	16.9	71.5	6.4
1st May	99.5	95.5	12.7	74.7	4.1
	99.0	94.4	13.4	74.1	4.6
	97.5	93.1	14.3	73.3	5.2
	95.0	92.1	14.9	72.8	5.6
	90.0	91.1	15.5	72.2	6.1
	75.0	89.7	16.4	71.4	6.7

contd..

BANGALORE CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
15th May	99.5	100.0	5.0	77.8	0.0
	99.0	97.9	6.6	76.9	1.1
	97.5	95.3	8.5	76.0	2.4
	95.0	93.6	9.8	75.3	3.4
	90.0	91.9	11.1	74.6	4.3
	75.0	89.5	12.9	73.7	5.5
1st June	99.5	87.3	13.4	74.4	3.0
	99.0	87.0	13.7	74.0	3.3
	97.5	86.7	14.0	73.6	3.7
	95.0	86.4	14.3	73.3	4.0
	90.0	86.1	14.6	73.0	4.3
	75.0	85.6	15.0	72.4	4.8
15th June	99.5	87.9	11.6	73.0	2.5
	99.0	87.4	12.1	72.6	2.8
	97.5	86.7	12.8	72.2	3.1
	95.0	86.1	13.3	72.9	3.4
	90.0	85.6	13.8	71.6	3.7
	75.0	84.9	14.5	71.2	4.1
1st July	99.5	82.3	5.1	71.3	2.6
	99.0	81.4	5.8	71.0	2.9
	97.5	80.4	6.7	70.5	3.1
	95.0	79.6	7.3	70.2	3.3
	90.0	78.9	7.9	69.9	3.5
	75.0	77.9	8.7	69.5	3.8
15th July	99.5	83.8	8.8	71.4	2.1
	99.0	83.4	9.3	71.1	2.4
	97.5	82.8	9.9	70.8	2.7
	95.0	82.4	10.4	70.5	3.0
	90.0	81.9	10.8	70.3	3.3
	75.0	81.3	11.5	69.9	3.7

BANGALORE CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st August	99.5	82.7	7.9	72.3	1.8
	99.0	82.1	8.4	72.0	2.2
	97.5	81.4	9.0	71.7	2.8
	95.0	80.9	9.5	71.4	3.2
	90.0	80.3	9.9	71.2	3.6
	75.0	79.5	10.6	70.8	4.2
15th August	99.0	82.6	7.8	73.8	2.1
	99.0	82.0	8.3	73.3	2.4
	97.5	81.4	8.8	72.6	2.8
	95.0	80.9	9.3	72.1	5.1
	90.0	80.4	9.7	71.6	3.4
	75.0	79.6	10.3	70.9	3.9
1st September	99.0	81.8	9.4	71.9	2.9
	99.0	81.5	9.8	71.6	3.1
	97.5	81.1	10.2	71.3	3.3
	95.0	80.8	10.6	71.0	3.5
	90.0	80.5	10.9	70.8	3.7
	75.0	80.1	11.4	70.4	4.0
15th September	99.0	85.9	10.4	71.7	3.1
	99.0	85.4	10.9	71.5	3.3
	97.5	84.7	11.5	71.2	3.5
	95.0	84.2	12.0	71.0	3.7
	90.0	83.7	12.5	70.8	3.8
	75.0	82.9	13.2	70.6	4.1

BARODA CITY

Date	Probability	Elements: Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st March	99.5	103.2	10.4	81.9	0.3
	99.0	100.1	15.8	78.7	2.9
	97.5	96.9	17.3	75.4	5.6
	95.0	95.0	19.4	73.4	7.3
	90.0	93.3	21.3	71.6	8.7
	75.0	91.2	23.6	69.5	10.4
15th March	95.5	108.3	20.1	75.0	9.0
	99.0	106.5	22.2	73.9	9.7
	97.5	104.5	24.7	72.6	10.6
	95.0	103.1	26.3	71.8	11.2
	90.0	101.9	27.8	71.0	11.7
	75.0	100.2	29.8	70.0	12.4
1st April	99.5	102.3	23.5	74.3	3.3
	99.0	101.7	24.3	73.8	9.1
	97.5	101.0	25.3	73.3	10.1
	95.0	100.5	26.0	72.9	10.8
	90.0	99.9	26.7	72.5	11.5
	75.0	99.2	27.7	72.0	12.6
15th April	99.5	103.2	20.7	76.9	8.3
	99.0	107.5	21.6	76.2	8.6
	97.5	106.7	22.7	75.3	9.1
	95.0	106.1	23.5	74.7	9.5
	90.0	105.4	24.4	74.0	9.9
	75.0	104.4	25.8	72.9	10.4
1st May	99.5	110.8	21.4	80.5	7.4
	99.0	110.1	22.1	79.9	8.0
	97.5	109.3	23.1	79.1	8.8
	95.0	108.7	23.8	78.6	9.3
	90.0	108.1	24.5	78.0	9.8
	75.0	107.2	25.5	77.2	10.6

Contd...

BARODA CITY

Date	Probability	Elements: Dry bulb temperature	Elements: Dry bulb temperature range	Elements: Wet bulb temperature	Elements: Wet bulb temperature range
15th May	99.5	110.3	22.2	81.0	7.2
	99.0	109.8	22.6	80.4	7.7
	97.5	109.2	23.1	79.8	8.3
	95.0	108.7	23.5	79.3	8.8
	90.0	108.2	23.9	78.7	9.3
	75.0	107.5	24.5	78.0	10.0
1st June	99.5	106.4	15.2	82.3	3.2
	99.0	105.8	15.6	82.1	3.7
	97.5	105.0	16.2	81.8	4.3
	95.0	104.4	16.6	81.5	4.8
	90.0	103.7	17.1	81.3	5.3
	75.0	102.8	17.7	80.9	6.0
15th June	99.5	101.9	13.7	83.3	3.3
	99.0	101.5	14.0	82.9	3.7
	97.5	101.0	14.5	82.5	4.2
	95.0	100.6	14.8	82.2	4.6
	90.0	100.2	15.1	81.9	5.1
	75.0	99.5	15.7	81.4	5.7
1st July	99.5	99.0	6.2	83.8	3.1
	99.0	98.0	7.0	83.5	3.4
	97.5	96.7	8.1	83.2	3.9
	95.0	95.7	8.8	82.9	4.3
	90.0	94.7	9.7	82.6	4.6
	75.0	93.1	10.9	82.2	5.2
15th July	99.5	96.2	7.7	83.6	2.0
	99.0	95.4	8.4	83.2	2.6
	97.5	94.4	9.3	82.7	3.4
	95.0	93.7	9.9	82.4	4.0
	90.0	93.0	10.6	82.0	4.6
	75.0	92.0	11.5	81.6	5.4

Contd....

BARODA CITY

Date	Probability	Elements: Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet Bulb temperature range
1st August	99.5	93.4	8.1	83.6	3.0
	99.0	92.9	8.5	83.2	3.3
	97.5	92.3	9.0	82.8	3.6
	95.0	91.8	9.4	82.5	3.9
	90.0	91.3	9.8	82.1	4.2
	75.0	90.6	10.4	81.6	4.6
15th August	99.5	90.8	5.8	81.8	3.3
	99.0	90.3	6.3	81.6	3.5
	97.5	89.7	7.0	81.3	3.8
	95.0	89.2	7.5	81.1	4.0
	90.0	88.7	8.0	80.8	4.2
	75.0	87.9	8.9	80.5	4.6
1st September	99.5	92.8	5.9	83.9	1.7
	99.0	92.0	6.5	83.3	2.2
	97.5	91.1	7.2	82.7	2.9
	95.0	90.4	7.8	82.2	3.3
	90.0	89.7	8.4	81.7	3.8
	75.0	86.7	9.2	81.0	4.5
15th September	99.5	94.0	8.6	86.0	0.9
	99.0	93.4	9.2	85.2	1.6
	97.5	92.6	10.0	84.2	2.5
	95.0	92.0	10.6	83.5	3.2
	90.0	91.4	11.2	82.7	4.0
	75.0	90.6	12.1	81.[illegible]	5.0

BHOPAL CITY

Date	Probability	Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
		Elements			
1st March	99.5	92.4	18.9	63.9	8.6
	99.0	91.6	19.7	63.2	9.0
	97.5	90.5	20.8	62.4	9.6
	95.0	89.6	21.6	61.7	10.1
	90.0	88.8	22.5	61.0	10.6
	75.0	87.5	23.7	60.0	11.3
15th March	99.5	97.3	21.3	64.7	8.3
	99.0	96.8	22.1	64.4	8.9
	97.5	96.1	23.1	64.0	9.7
	95.0	95.6	23.9	63.7	10.3
	90.0	95.1	24.7	63.4	10.9
	75.0	94.3	25.9	63.0	11.7
1st April	99.5	98.5	22.6	70.6	11.5
	99.0	98.0	23.1	69.7	12.0
	97.5	97.4	23.8	68.6	12.7
	95.0	96.9	24.2	67.7	13.2
	90.0	96.4	24.7	66.9	13.8
	75.0	95.7	25.5	65.6	14.5
16th April	99.5	104.3	21.5	71.6	10.8
	99.0	103.7	22.2	70.8	11.2
	97.5	103.0	23.0	69.9	11.8
	95.0	102.5	23.6	69.3	12.2
	90.0	102.0	24.2	68.6	12.6
	75.0	101.3	25.0	67.7	13.2
1st May	99.5	107.1	18.0	73.9	11.1
	99.0	106.5	18.9	73.1	11.8
	97.5	105.7	20.0	72.1	12.8
	95.0	105.0	20.9	71.3	13.5
	90.0	104.4	21.8	70.5	14.3
	75.0	103.4	23.2	69.4	15.4

contd...

BHOPAL CITY

Date	Probability	Elements: Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
15th May	99.5	107.9	19.9	75.5	9.0
	99.0	107.3	20.4	74.8	9.8
	97.5	106.4	21.1	73.9	10.8
	95.0	105.7	21.6	73.3	11.5
	90.0	105.0	22.1	72.6	12.4
	75.0	103.9	22.9	71.5	13.6
1st June	99.5	107.8	15.5	79.1	8.7
	99.0	106.9	16.0	78.5	9.4
	97.5	105.8	16.7	77.6	10.3
	95.0	105.0	17.2	77.0	11.0
	90.0	104.1	17.7	76.3	11.7
	75.0	102.9	18.5	75.3	12.7
15th June	99.5	105.7	15.0	77.4	4.7
	99.0	104.7	15.4	77.1	5.5
	97.5	103.5	16.0	76.8	6.5
	95.0	102.6	16.5	76.5	7.2
	90.0	101.7	16.9	76.3	7.9
	75.0	100.4	17.5	76.0	8.9
1st July	99.5	96.9	1.8	79.2	1.8
	99.0	95.0	3.3	78.7	2.2
	97.5	92.7	5.0	78.2	2.7
	95.0	91.1	6.3	77.7	3.0
	90.0	89.5	7.5	77.3	3.3
	75.0	87.4	9.1	76.8	3.8
15th July	99.5	90.7	4.4	77.4	2.0
	99.0	89.8	5.1	77.1	2.3
	97.5	88.7	6.1	76.8	2.7
	95.0	87.8	6.7	76.5	3.0
	90.0	86.9	7.4	76.3	3.3
	75.0	85.6	8.5	75.9	3.8

contd..

BHOPAL CITY

Date	Probability	Elements			
		Dry. bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st August	99.5	85.7	3.3	78.7	2.5
	99.0	85.1	3.9	78.3	2.8
	97.5	84.2	4.7	77.9	3.1
	95.0	83.6	5.2	77.6	3.4
	90.0	83.0	5.8	77.2	3.6
	75.0	82.1	6.6	76.8	4.0
15th August	99.5	86.4	2.9	77.4	3.0
	99.0	85.6	3.6	77.1	3.1
	97.5	84.7	4.5	76.7	3.2
	95.0	84.0	5.2	76.4	3.3
	90.0	83.3	5.8	76.1	3.4
	75.0	82.3	6.8	75.8	3.6
1st September	99.5	88.5	6.8	79.4	3.4
	99.0	87.8	7.3	79.0	3.7
	97.5	86.9	7.9	78.5	4.0
	95.0	86.3	8.4	78.1	4.3
	90.0	85.6	8.9	77.7	4.5
	75.0	84.6	9.6	77.0	4.9
15th September	99.5	87.0	10.5	78.1	3.6
	99.0	86.7	10.9	77.6	3.9
	97.5	86.4	11.5	77.0	4.2
	95.0	86.2	11.9	76.6	4.5
	90.0	86.0	12.4	76.2	4.7
	75.0	85.6	13.0	75.5	5.1

BOMBAY CITY (COLABA)

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st March	99.5	88.4	10.3	78.2	6.2
	99.0	87.9	10.7	77.7	6.8
	97.5	87.4	11.2	77.1	7.5
	95.0	87.0	11.6	76.6	8.0
	90.0	86.5	12.1	76.0	8.6
	75.0	85.8	12.7	75.3	9.4
15th March	99.5	88.9	10.2	79.6	4.6
	99.0	88.6	10.4	79.2	4.9
	97.5	88.2	10.7	78.7	5.4
	95.0	88.0	10.9	78.3	5.7
	90.0	87.7	11.1	77.8	6.0
	75.0	87.3	11.4	77.2	6.5
1st April	99.5	89.3	9.1	79.1	3.2
	99.0	89.0	9.3	78.7	3.5
	97.5	88.5	9.5	78.3	3.8
	95.0	88.2	9.7	78.0	4.0
	90.0	87.8	9.8	77.7	4.3
	75.0	87.3	10.1	77.2	4.7
15th April	99.5	92.6	7.4	81.2	3.1
	99.0	92.2	7.8	80.8	3.4
	97.5	91.7	8.2	80.3	3.9
	95.0	91.4	8.6	80.0	4.2
	90.0	91.0	8.9	79.6	4.5
	75.0	90.4	9.5	79.1	5.1
1st May	99.5	97.4	5.1	87.3	0.4
	99.0	96.7	5.9	86.6	1.3
	97.5	95.8	6.9	85.6	2.4
	95.0	95.2	7.7	85.0	3.2
	90.0	94.5	8.5	84.2	4.1
	75.0	93.5	9.7	83.2	5.4

contd..

BOMBAY CITY (COLABA)

Date	Probability	Elements: Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
15th May	99.5	91.9	4.5	82.9	0.8
	99.0	91.7	5.2	82.6	1.5
	97.5	91.4	6.1	82.2	2.4
	95.0	91.2	6.8	81.9	3.1
	90.0	91.0	7.5	81.7	3.8
	75.0	90.7	8.6	81.2	4.9
1st June	99.5	93.2	6.9	83.5	1.6
	99.0	93.0	7.1	83.2	2.0
	97.5	92.7	7.3	82.9	2.5
	95.0	92.5	7.5	82.6	2.8
	90.0	92.3	7.7	82.3	3.2
	75.0	92.0	8.0	81.9	3.8
15th June	99.5	92.7	6.6	82.2	3.2
	99.0	92.2	6.9	82.0	3.4
	97.5	91.6	7.1	81.8	3.6
	95.0	91.2	7.4	81.6	3.8
	90.0	90.7	7.6	81.4	4.0
	75.0	90.0	7.9	81.2	4.2
1st July	99.5	87.3	2.7	81.1	2.0
	99.0	86.8	2.9	80.8	2.1
	97.5	86.1	3.3	80.5	2.3
	95.0	85.6	3.5	80.3	2.4
	90.0	85.1	3.8	80.0	2.5
	75.0	84.3	4.1	79.7	2.6
15th July	99.5	87.7	4.1	81.6	2.3
	99.0	87.4	4.3	81.4	2.4
	97.5	87.1	4.6	81.2	2.7
	95.0	86.8	4.9	81.0	2.8
	90.0	86.5	5.1	80.8	3.0
	75.0	86.1	5.5	80.5	3.3

BOMBAY CITY (COLABA)

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st August	99.5	86.4	3.7	80.8	1.9
	99.0	86.0	3.9	80.5	2.1
	97.5	85.5	4.2	80.2	2.5
	95.0	85.2	4.5	80.0	2.7
	90.0	84.8	4.8	79.8	3.0
	75.0	84.2	5.2	79.4	3.4
15th August	99.5	87.8	1.7	82.7	1.0
	99.0	87.2	2.3	82.2	1.6
	97.5	86.4	3.2	81.6	2.4
	95.0	85.8	3.9	81.1	3.0
	90.0	85.1	4.6	80.7	3.7
	75.0	84.2	5.6	79.9	4.6
1st September	99.5	87.9	2.4	82.1	0.7
	99.0	87.4	2.9	81.7	1.1
	97.5	86.8	3.5	81.3	1.6
	95.0	86.3	3.9	80.9	2.0
	90.0	85.8	4.4	80.5	2.5
	75.0	85.1	5.1	80.0	3.1
15th September	99.5	87.1	3.6	79.6	2.0
	99.0	86.8	3.9	79.4	2.2
	97.5	86.3	4.3	79.3	2.5
	95.0	86.0	4.6	79.1	2.8
	90.0	85.7	5.0	79.0	3.0
	75.0	85.1	5.5	78.8	3.4

BOMBAY CITY (SANTA CRUZ)

Date	Probability	Elements: Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st March	99.5	125.7	27.5	74.5	38.9
	99.0	114.6	12.8	73.4	23.3
	97.5	103.7	1.7	72.2	7.9
	95.0	99.5	7.2	71.8	2.0
	90.0	95.7	12.3	71.4	3.4
	75.0	91.7	17.6	71.0	9.0
15th March	99.5	91.4	12.2	79.3	5.5
	99.0	90.4	12.9	78.3	6.3
	97.5	89.3	13.8	77.2	7.3
	95.0	88.5	14.3	76.5	7.9
	90.0	87.9	14.8	75.8	8.5
	75.0	86.9	15.5	74.9	9.2
1st April	99.5	93.4	11.1	80.6	2.6
	99.0	92.4	11.8	79.6	3.5
	97.5	91.2	12.6	78.5	4.4
	95.0	90.4	13.2	77.8	5.1
	90.0	89.7	13.7	77.1	5.7
	75.0	88.7	14.4	76.2	6.5
15th April	99.5	92.4	8.9	80.2	2.5
	99.0	91.8	9.3	79.7	3.1
	97.5	91.1	9.9	79.1	3.8
	95.0	90.6	10.3	78.6	4.3
	90.0	90.1	10.6	78.2	4.7
	75.0	89.4	11.2	77.7	5.4
1st May	99.5	93.1	9.6	81.6	4.0
	99.0	92.8	9.8	81.3	4.3
	97.5	92.3	10.1	81.0	4.6
	95.0	92.0	10.3	80.8	4.9
	90.0	91.7	10.6	80.6	5.2
	75.0	91.2	10.9	80.3	5.6

contd..

BOMBAY CITY (SANTA CRUZ)

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
15th May	99.5	91.2	6.9	81.9	2.5
	99.0	91.1	7.4	81.6	2.9
	97.5	90.8	8.0	81.1	3.3
	95.0	90.6	8.5	80.8	3.6
	90.0	90.4	8.9	80.5	4.0
	75.0	90.2	9.6	80.1	4.5
1st June	99.5	92.2	6.7	80.9	2.6
	99.0	92.0	6.9	80.7	2.8
	97.5	91.6	7.2	80.5	3.1
	95.0	91.4	7.4	80.4	3.2
	90.0	91.1	7.6	80.2	3.4
	75.0	90.7	7.9	80.0	3.7
15th June	99.5	91.4	5.9	81.7	2.1
	99.0	91.0	6.2	81.5	2.4
	97.5	90.6	6.5	81.2	2.8
	95.0	90.3	6.8	81.0	3.1
	90.0	89.9	7.2	80.7	3.4
	75.0	89.4	7.6	80.4	3.9
1st July	99.5	87.2	4.4	81.3	2.5
	99.0	86.8	4.7	81.1	2.8
	97.5	86.4	5.0	80.9	3.1
	95.0	86.0	5.3	80.7	3.4
	90.0	85.7	5.5	80.5	3.7
	75.0	85.1	6.0	80.2	4.1
15th July	99.5	86.7	3.9	80.7	2.4
	99.0	86.5	4.2	80.5	2.6
	97.5	86.2	4.6	80.3	2.8
	95.0	86.0	4.9	80.1	3.0
	90.0	85.8	5.3	80.0	3.1
	75.0	85.5	5.8	79.7	3.4

contd..

BOMBAY CITY (SANTA CRUZ)

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st August	99.5	86.1	3.0	80.9	2.8
	99.0	85.7	3.3	80.6	3.0
	97.5	85.3	3.7	80.3	3.3
	95.0	84.9	4.0	80.1	3.5
	90.0	84.5	4.4	79.8	3.7
	75.0	83.9	4.9	79.5	4.0
15th August	99.5	84.3	3.5	79.1	2.3
	99.0	84.0	3.7	79.0	2.5
	97.5	83.7	4.0	78.8	2.8
	95.0	83.4	4.2	78.7	3.0
	90.0	83.1	4.4	78.5	3.2
	75.0	82.7	4.8	78.3	3.5
1st September	99.5	85.3	3.4	79.5	2.5
	99.0	85.0	3.8	79.3	2.7
	97.5	84.7	4.3	79.1	2.9
	95.0	84.4	4.7	79.0	3.1
	90.0	84.2	5.0	78.8	3.3
	75.0	83.8	5.6	78.6	3.5
15th September	99.5	86.3	4.4	80.0	2.9
	99.0	86.0	4.9	79.8	3.2
	97.5	85.6	5.4	79.5	3.5
	95.0	85.3	5.9	79.3	3.8
	90.0	85.0	6.4	79.1	4.1
	75.0	84.5	7.1	78.8	4.5

DELHI CITY

ESTIMATION OF MAXIMUM DRY BULB TEMPERATURE, MINIMUM DRY BULB TEMPERATURE RANGE, MAXIMUM WET BULB TEMPERATURE, MINIMUM WET BULB TEMPERATURE RANGE FOR DELHI FOR VARIOUS CONFIDENCE LIMITS.

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
	99.5	85.4	19.0	63.9	8.1
	99.0	84.9	19.5	63.4	8.3
Ist March	97.5	84.1	20.2	62.8	8.6
	95.0	83.6	20.8	62.4	8.8
	90.0	83.0	21.4	61.9	9.0
	75.0	82.2	22.2	61.2	9.3
	99.5	93.6	15.9	68.2	6.2
	99.0	92.9	16.8	67.8	6.5
15th March	97.0	91.9	17.9	67.2	6.9
	95.0	91.3	18.8	66.7	7.4
	90.0	90.5	19.7	66.3	7.6
	75.0	89.5	21.1	65.6	8.1
	99.5	94.5	18.5	66.6	7.9
	99.0	94.0	19.0	66.1	8.2
Ist April	97.0	93.2	19.6	65.6	8.5
	95.0	92.6	20.1	65.1	8.8
	90.0	92.0	20.6	64.6	9.1
	75.0	91.0	21.4	63.9	9.5
	99.5	101.6	18.1	71.7	8.7
	99.0	101.0	18.7	71.0	9.1
15th April	97.0	100.1	19.4	70.2	9.6
	95.0	99.4	19.9	69.5	10.0
	90.0	98.7	20.4	68.8	10.4
	75.0	97.7	21.4	67.8	11.1
	99.5	104.4	20.3	73.7	9.4
	99.0	104.0	20.7	73.2	9.9
Ist May	97.0	103.4	21.2	72.6	10.6
	95.0	103.0	21.6	72.0	11.1
	90.0	102.6	22.0	71.5	11.6
	75.0	102.0	22.5	70.7	12.4

contd...

DELHI CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
	99.5	104.7	17.7	72.0	8.0
	99.0	104.2	18.2	71.7	8.5
15th May	97.5	103.6	18.9	71.2	9.1
	95.0	103.1	19.4	70.8	9.5
	90.0	102.6	20.0	70.5	10.0
	75.0	101.9	20.8	69.9	10.7
	99.5	108.5	15.6	77.3	4.6
	99.0	107.8	16.2	76.7	5.5
Ist June	97.5	107.0	16.9	75.8	6.6
	95.0	106.4	17.5	75.2	7.5
	90.0	105.7	18.0	74.6	8.4
	75.0	104.8	18.9	73.6	9.7
	99.5	109.6	11.4	78.2	5.6
	99.0	108.7	12.1	77.9	6.3
15th June	97.5	107.6	12.9	77.4	7.1
	95.0	106.7	13.5	77.0	7.7
	90.0	105.8	14.2	76.6	8.4
	75.0	104.5	15.1	76.1	9.3
	99.5	103.6	9.7	82.2	2.9
	99.0	102.7	10.3	81.8	3.4
Ist July	97.5	101.5	11.0	81.4	4.2
	95.0	100.5	11.5	81.0	4.7
	90.0	99.6	12.1	80.7	5.3
	75.0	98.2	12.9	80.2	6.2
	99.5	100.2	8.3	84.6	4.2
	99.0	99.5	8.8	84.2	4.4
	97.5	98.5	9.4	83.6	4.7
15th July	95.0	97.8	9.3	83.2	4.9
	90.0	97.0	10.3	82.8	5.1
	75.0	95.9	11.0	82.1	5.4

contd...

DELHI CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
Ist August	99.5	97.6	7.6	83.7	3.4
	99.0	96,8	8.1	83.4	3.7
	97.5	95.8	8.0	83.0	4.2
	95.0	95.1	9.0	82.7	4.5
	90.0	94.3	9.4	82.4	4.8
	75.0	93.2	10.0	82.0	5.3
15th August	99.5	98.9	2.1	86.5	2.1
	99.0	97.6	3.2	85.9	2.8
	97.5	96.0	4.5	85.1	3.6
	95.0	94.8	5.5	84.6	4.2
	90.0	93.6	6.4	84.0	4.8
	75.0	92.0	7.8	83.3	5.6
Ist Sept.	99.5	98.1	6.7	83.9	4.0
	99.0	97.1	7.3	83.5	4.2
	97.5	95.8	8.0	82.9	4.6
	95.0	94.9	8.6	82.4	4.8
	90.0	94.0	9.1	82.0	5.1
	75.0	92.7	9.9	81.4	5.4
	99.5	94.4	8.9	81.2	3.4
	99.0	94.0	9.5	80.8	3.8
	97.5	93.4	10.4	80.3	4.2
	95.0	93.0	11.0	80.0	4.6
	90.0	92.5	11.7	79.6	5.0
	75.0	91.8	12.7	79.0	5.0

HYDERABAD CITY

Date	Probability	Elements: Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature
March 15th	99.5	97.0	20.3	69.6	3.7
	99.0	96.5	20.9	69.1	4.6
	97.5	95.9	21.7	68.4	5.7
	95.0	95.5	22.2	67.9	6.4
	90.0	95.1	22.8	67.4	7.1
	75.0	94.5	23.5	66.8	8.1
1st April	99.5	104.5	11.3	76.0	4.3
	99.0	103.0	12.9	74.3	5.3
	97.5	101.2	14.9	73.4	6.5
	95.0	99.9	16.3	72.5	7.3
	90.0	98.7	17.7	71.5	8.1
	75.0	97.0	19.6	70.2	9.2
15th April	99.5	98.6	20.4	71.7	4.3
	99.0	98.4	21.1	71.3	5.0
	97.5	98.1	22.0	70.8	5.8
	95.0	97.9	22.6	70.5	6.4
	90.0	97.8	23.2	70.2	7.0
	75.0	97.6	24.0	69.7	7.7
15th May	99.5	100.8	12.1	75.6	3.7
	99.0	100.1	12.8	75.2	4.0
	97.5	99.4	13.7	74.8	4.5
	95.0	98.8	14.3	74.5	4.8
	90.0	98.3	14.9	74.2	5.1
	75.0	97.5	15.8	73.7	5.5
1st June	99.5	104.0	15.2	76.7	4.1
	99.0	103.0	15.6	76.2	4.6
	97.5	101.8	16.0	75.8	5.2
	95.0	100.9	16.3	75.4	5.6
	90.0	100.0	16.7	75.1	6.0
	75.0	98.7	17.2	74.5	6.7

Contd...

HYDERABAD CITY

Date	Probability	Elements			
		Dry Bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
15th June	99.5	97.9	12.0	75.0	3.2
	99.0	97.1	12.5	74.7	3.7
	97.5	96.0	13.1	74.4	4.3
	95.0	95.2	13.5	74.2	4.7
	90.0	94.4	13.9	74.0	5.2
	75.0	93.2	14.6	73.7	5.9
1st July	99.5	89.6	2.5	74.3	1.5
	99.0	88.3	3.8	74.0	1.9
	97.5	86.8	5.3	73.6	2.4
	95.0	85.7	6.3	73.4	2.8
	90.0	84.8	7.2	73.2	3.1
	75.0	83.6	8.4	72.9	3.5
15th July	99.5	89.2	6.5	75.5	3.2
	99.0	88.5	7.2	75.2	3.4
	97.5	87.7	8.0	74.9	3.5
	95.0	87.0	8.6	74.6	3.7
	90.0	86.4	9.3	74.3	3.8
	75.0	85.5	10.2	73.9	4.0
1st August	99.5	84.6	5.6	77.6	2.6
	99.0	83.9	5.9	77.1	2.9
	97.5	83.1	6.4	76.5	3.3
	95.0	82.5	6.8	76.0	3.6
	90.0	81.9	7.1	75.6	3.8
	75.0	81.0	7.6	75.0	4.2
15th August	99.5	88.3	5.4	76.3	2.1
	99.0	87.4	6.1	76.0	2.7
	97.5	86.2	7.0	75.6	3.4
	95.0	85.4	7.7	75.3	3.9
	90.0	84.5	8.3	75.0	4.4
	75.0	83.4	9.2	74.6	5.1

Contd...

HYDERABAD CITY

Date	Probability	Elements: Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st September	99.5	89.2	7.2	77.0	1.9
	99.0	88.5	7.8	76.6	2.3
	97.5	87.6	8.6	76.2	2.9
	95.0	87.0	9.2	75.9	3.2
	90.0	86.3	9.3	75.6	3.6
	75.0	85.4	10.6	75.2	4.2
15th September	99.5	88.9	5.4	76.9	3.5
	99.0	88.1	6.1	76.5	3.7
	97.5	87.0	7.0	76.1	4.0
	95.0	86.3	7.7	75.7	4.2
	90.0	85.5	8.4	75.4	4.4
	75.0	84.4	9.5	74.9	4.7

JAIPUR CITY

Date	Probability	Elements: Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st March	99.5	90.1	19.2	64.3	7.4
	99.0	89.3	19,8	63.7	8.1
	97.5	88,2	20.7	62.9	8.9
	95.0	87.4	21.4	62.3	9.5
	90.0	86.5	22.1	61.6	10.2
	75.0	85.3	23.1	60.7	11.1
15th March	99.5	97.5	18.7	64.7	8.6
	99.0	96.7	19.8	64.2	9.1
	97.5	95.7	21.1	63.6	9.6
	95.0	95.0	22.1	63.2	10.1
	90.0	94.2	23.0	62.7	10.5
	75.0	93.2	24.4	62.1	11.1
1st April	99.5	96.3	17.0	64.3	8.9
	99.0	95.6	17.7	63.8	9.4
	97.5	94.7	18.7	63.2	9.9
	95.0	94.0	19.4	62.8	10.3
	90.0	93.2	20.1	62.3	10.7
	75.0	92.2	21.1	61.7	11.3
15th April	99.5	104.4	11.5	66.2	7.1
	99.0	103.3	12.9	65.8	7.7
	97.5	102.0	14.7	65.3	8.5
	95.0	101.0	16.0	64.9	9.1
	90.0	99.9	17.4	64.5	9.7
	75.0	98.3	19.5	63.9	10.6
1st May	99.5	107.0	21.6	68.9	9.4
	99.0	106.6	22.2	68.6	9.9
	97.5	106.0	23.0	68.2	10.5
	95.0	105.6	23.5	67.9	11.0
	90.0	105.1	24.2	67.6	11.5
	75.0	104.4	25.1	67.1	12.3

contd...

JAIPUR CITY

Date	Probability	Elements: Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
15th May	99.5	105.6	17.9	70.9	11.3
	99.0	105.2	18.5	70.4	11.7
	97.5	104.8	19.4	69.8	12.1
	95.0	104.5	20.1	69.3	12.5
	90.0	104.2	20.8	68.8	12.8
	75.0	103.7	21.8	68.0	13.3
1st June	99.5	106.8	15.6	79.2	8.0
	99.0	106.3	16.2	78.5	8.6
	97.5	105.7	17.0	77.6	9.3
	95.0	105.2	17.6	76.8	9.9
	90.0	104.8	18.3	76.1	10.5
	75.0	104.0	19.2	75.0	11.3
15th June	99.5	107.3	14.7	80.2	7.3
	99.0	106.6	15.1	79.7	7.9
	97.5	105.7	15.7	79.2	8.5
	95.0	105.0	16.2	78.8	9.1
	90.0	104.3	16.7	78.3	9.6
	75.0	103.1	17.4	77.7	10.4
1st July	99.5	101.8	9.9	86.6	2.2
	99.0	100.9	10.6	85.7	2.8
	97.5	99.9	11.6	84.6	3.6
	95.0	99.1	12.3	83.8	4.2
	90.0	98.3	13.1	82.9	4.8
	75.0	97.1	14.1	81.7	5.7
15th July	99.5	96.1	7.3	80.9	2.5
	99.0	95.4	7.8	80.5	2.7
	97.5	94.4	8.5	80.0	2.9
	95.0	93.6	9.0	79.6	3.1
	90.0	92.9	9.5	79.2	3.2
	75.0	91.7	10.2	78.7	3.5

contd...

JAIPUR CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st August	99.5	96.6	7.5	81.5	2.6
	99.0	95.8	8.3	81.1	2.8
	97.5	94.9	9.3	80.7	3.1
	95.0	94.2	10.0	80.4	3.3
	90.0	93.5	10.8	80.0	3.5
	75.0	92.4	11.9	79.5	3.9
15th August	99.5	94.1	3.0	80.2	2.2
	99.0	93.1	3.8	80.0	2.3
	97.5	91.7	4.8	79.6	2.5
	95.0	90.7	5.5	79.3	2.7
	90.0	89.7	6.3	79.1	2.9
	75.0	88.2	7.4	78.7	3.1
1st September	99.5	92.4	4.3	82.8	1.7
	99.0	91.7	4.9	82.4	2.2
	97.5	90.7	5.7	81.8	2.7
	95.0	89.9	6.3	81.4	3.1
	90.0	89.2	6.9	81.0	3.6
	75.0	88.1	7.8	80.4	4.2
15th September	99.5	93.5	6.8	79.5	3.2
	99.0	92.8	7.9	79.0	3.4
	97.5	91.9	9.1	78.4	3.6
	95.0	91.2	10.1	78.0	3.8
	90.0	90.6	11.1	77.5	4.0
	75.0	89.6	12.5	76.9	4.3

JODHPUR CITY

Date	Probability	Elements: Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st March	99.5	94.6	23.2	63.5	11.3
	99.0	93.8	23.7	63.0	11.6
	97.5	92.8	24.4	62.3	12.1
	95.0	92.0	25.0	61.7	12.5
	90.0	91.2	25.6	61.2	12.8
	75.0	89.9	26.4	60.3	13.4
15th March	99.5	100.4	19.7	68.2	9.3
	99.0	99.4	20.6	67.6	9.9
	97.5	98.1	21.8	66.7	10.7
	95.0	97.1	22.8	66.1	11.3
	90.0	96.1	23.7	65.5	11.9
	75.0	94.6	25.1	64.5	12.9
1st April	99.5	99.5	21.0	67.6	10.6
	99.0	98.9	21.4	67.0	10.9
	97.5	98.2	22.0	66.3	11.3
	95.0	97.6	22.5	65.8	11.6
	90.0	96.9	22.9	65.2	12.0
	75.0	96.0	23.6	64.3	12.5
15th April	99.5	105.9	19.5	70.7	11.1
	99.0	105.2	20.2	70.2	11.6
	97.5	104.3	21.2	69.5	12.3
	95.0	103.7	21.8	69.0	12.8
	90.0	103.0	22.5	68.6	13.3
	75.0	102.0	23.6	67.8	14.0
1st May	99.5	110.5	22.8	73.5	12.6
	99.0	110.1	23.5	73.0	12.9
	97.5	109.5	24.2	72.3	13.2
	95.0	109.0	24.8	71.7	13.5
	90.0	108.6	25.4	71.2	13.7
	75.0	107.9	26.3	70.4	14.1

Contd...

JODHPUR CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
15th May	99.5	108.9	18.8	75.4	10.7
	99.0	108.2	19.1	74.8	11.2
	97.5	107.4	19.5	74.0	11.8
	95.0	106.7	19.8	73.3	12.2
	90.0	106.0	20.2	72.7	12.7
	75.0	105.0	20.6	71.3	13.4
1st June	99.5	108.7	17.6	81.5	3.0
	99.0	108.2	18.0	80.7	4.2
	97.5	107.4	18.5	79.8	5.7
	95.0	106.9	18.9	79.1	6.7
	90.0	106.4	19.3	78.4	7.7
	75.0	105.7	19.8	77.3	9.2
15th June	99.5	106.8	15.3	80.2	4.7
	99.0	106.3	15.7	79.8	5.4
	97.5	105.8	16.2	79.3	6.2
	95.0	105.4	16.5	79.0	6.8
	90.0	105.0	16.9	78.6	7.5
	75.0	104.4	17.5	78.0	8.4
1st July	99.5	104.0	13.1	83.6	1.8
	99.0	103.4	13.5	83.1	2.3
	97.5	102.7	14.0	82.5	3.0
	95.0	102.2	14.3	82.1	3.4
	90.0	101.6	14.6	81.6	3.8
	75.0	100.9	15.1	81.0	4.5
15th July	99.5	101.1	6.9	82.1	2.9
	99.0	100.1	7.7	81.6	3.0
	97.5	98.9	8.7	81.0	3.3
	95.0	97.9	9.4	80.6	3.5
	90.0	96.9	10.1	80.2	3.6
	75.0	95.5	11.2	79.5	3.9

Contd...

JODHPUR CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st August	99.5	97.3	8.0	81.0	2.4
	99.0	96.6	8.4	80.7	2.7
	97.5	95.7	9.1	80.3	3.0
	95.0	95.1	9.6	80.0	3.2
	90.0	94.4	10.1	79.7	3.5
	75.0	93.3	10.9	79.2	3.9
15th August	99.5	96.5	7.8	80.8	2.4
	99.0	95.6	7.9	80.4	2.7
	97.5	94.4	8.7	80.0	3.1
	95.0	93.6	9.2	79.7	3.4
	90.0	92.7	9.8	79.4	3.7
	75.0	91.4	10.6	78.9	4.2
1st September	99.5	98.2	3.5	80.2	1.8
	99.0	96.7	4.6	79.8	2.2
	97.5	94.9	6.1	79.3	2.6
	95.0	93.6	7.1	78.9	2.9
	90.0	92.4	8.0	78.5	3.2
	75.0	90.7	9.4	78.0	3.6
15th September	99.5	96.9	9.7	78.8	3.0
	99.0	96.2	10.4	78.4	3.2
	97.5	95.2	11.4	77.9	3.5
	95.0	94.5	12.2	77.5	3.7
	90.0	93.3	13.0	77.1	3.9
	75.0	92.7	14.1	76.5	4.2

LUCKNOW CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st March	99.5	84.0	19.7	68.0	5.0
	99.0	83.2	20.7	67.0	6.0
	97.5	82.3	21.8	65.9	7.2
	95.0	81.7	22.5	65.1	8.0
	90.0	81.1	23.3	64.8	8.8
	75.0	80.2	24.8	63.2	9.9
15th March	99.5	113.5	4.9	104.1	5.4
	99.0	107.0	12.1	92.2	6.7
	97.5	100.6	19.3	80.4	7.9
	95.0	98.2	22.0	75.9	8.4
	90.0	95.9	24.6	71.7	8.8
	75.0	93.6	27.2	67.4	9.3
1st April	99.5	98.5	19.7	70.4	4.7
	99.0	97.5	20.6	69.7	5.4
	97.5	96.4	21.7	68.9	6.4
	95.0	95.6	22.5	68.3	7.0
	90.0	94.7	23.2	67.7	7.7
	75.0	93.5	24.4	66.9	8.7
15th April	99.5	106.2	22.9	72.5	8.6
	99.0	105.4	23.7	71.9	9.0
	97.5	104.4	24.6	71.2	9.6
	95.0	103.7	25.4	70.6	10.0
	90.0	102.9	26.2	70.0	10.5
	75.0	101.7	27.3	69.1	11.1
1st May	99.5	108.3	16.5	76.1	7.8
	99.0	107.3	18.4	75.4	8.6
	97.5	106.0	20.6	74.5	9.5
	95.0	105.1	22.2	73.8	10.2
	90.0	104.3	23.7	73.2	10.8
	75.0	103.1	25.8	72.4	11.6

Contd...

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
15th May	99.5	108.4	14.5	79.9	8.1
	99.0	107.4	15.9	78.8	8.9
	97.5	106.1	17.7	77.6	9.7
	95.0	105.1	18.9	76.6	10.4
	90.0	104.2	20.1	75.7	11.0
	75.0	102.9	21.9	74.4	11.9
1st June	99.5	113.5	13.3	85.1	4.5
	99.0	112.1	14.5	83.7	5.3
	97.5	110.3	16.0	82.1	6.3
	95.0	109.0	17.2	80.9	7.0
	90.0	107.7	18.3	79.6	7.7
	75.0	105.8	19.9	77.9	8.7
15th June	99.5	114.9	5.5	84.1	2.3
	99.0	112.7	7.4	83.2	3.1
	97.5	110.1	9.6	82.1	4.1
	95.0	108.3	11.2	81.3	4.8
	90.0	106.5	12.7	80.5	5.5
	75.0	104.1	14.8	79.5	6.4
1st July	99.5	99.2	8.8	84.5	3.6
	99.0	98.5	9.3	84.1	4.1
	97.5	97.6	10.1	83.7	4.7
	95.0	96.9	10.7	83.3	5.1
	90.0	96.2	11.2	83.0	5.6
	75.0	95.2	12.1	82.4	6.3
15th July	99.5	100.3	3.1	87.6	3.7
	99.0	98.6	4.4	86.7	4.2
	97.5	96.6	6.0	85.7	4.8
	95.0	95.3	7.2	85.0	5.3
	90.0	93.9	8.2	84.2	5.7
	75.0	92.1	9.8	83.3	6.3

Contd...

LUCKNOW CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st August	99.5	93.0	4.3	83.0	3.1
	99.0	92.2	5.1	82.7	3.5
	97.5	91.2	6.0	82.4	3.9
	95.0	90.6	6.6	82.1	4.2
	90.0	89.9	7.3	81.9	4.5
	75.0	89.0	8.1	81.6	4.9
15th August	99.5	95.4	6.2	85.9	1.9
	99.0	94.6	7.1	85.3	2.7
	97.5	93.6	8.1	84.7	3.5
	95.0	92.9	8.8	84.3	4.1
	90.0	92.3	9.5	83.8	4.6
	75.0	91.5	10.3	83.3	5.3
1st September	99.5	91.7	4.5	81.8	2.5
	99.0	90.9	4.9	81.5	2.7
	97.5	89.8	5.4	81.2	3.0
	95.0	89.1	5.7	80.9	3.3
	90.0	88.4	6.1	80.7	3.5
	75.0	87.3	6.6	80.3	3.9
15th September	99.5	93.5	8.1	83.8	1.8
	99.0	92.8	8.9	83.1	2.6
	97.5	91.9	9.8	82.4	3.6
	95.0	91.4	10.4	81.9	4.2
	90.0	90.8	11.0	81.4	4.7
	75.0	90.2	11.3	80.8	5.5

MADRAS CITY

Date	Probability	Elements: Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st March	99.5	91.1	11.0	78.3	2.4
	99.0	90.7	11.6	77.9	2.8
	97.5	90.3	12.3	77.3	3.3
	95.0	89.9	12.9	76.9	3.7
	90.0	89.5	13.4	76.5	4.1
	75.0	88.9	14.3	75.8	4.8
15th March	99.5	93.1	13.1	77.6	3.2
	99.0	92.7	13.4	77.3	3.6
	97.5	92.2	13.9	77.0	4.0
	95.0	91.8	14.3	76.8	4.3
	90.0	91.5	14.6	76.5	4.7
	75.0	91.0	15.1	76.2	5.1
1st April	99.5	94.2	12.4	79.6	2.3
	99.0	93.9	12.7	79.3	2.5
	97.5	93.5	13.0	79.0	2.9
	95.0	93.2	13.3	78.8	3.1
	90.0	92.9	13.6	78.6	3.4
	75.0	92.5	14.1	78.2	3.8
15th April	99.5	97.7	10.5	82.2	2.6
	99.0	97.3	11.1	81.9	2.9
	97.5	96.8	11.9	81.5	3.2
	95.0	96.4	12.5	81.3	3.5
	90.0	96.0	13.1	81.0	3.7
	75.0	95.5	13.9	80.6	4.0
1st May	99.5	98.8	12.7	83.4	3.7
	99.0	98.4	12.9	83.1	4.0
	97.5	97.8	13.2	82.6	4.4
	95.0	97.3	13.5	82.3	4.7
	90.0	96.8	13.7	82.0	5.0
	75.0	96.1	14.1	81.5	5.5

Contd...

MADRAS CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
15th May	99.5	101.0	10.3	81.8	3.7
	99.0	100.2	10.7	81.6	4.1
	97.5	99.1	11.2	81.3	4.5
	95.0	98.2	11.6	81.2	4.8
	90.0	97.4	12.0	81.0	5.1
	75.0	96.2	12.6	80.7	5.5
1st June	99.5	102.1	14.3	83.5	6.4
	99.0	101.7	14.6	83.2	6.7
	97.5	101.2	15.0	82.8	7.0
	95.0	100.9	15.2	82.6	7.2
	90.0	100.5	15.5	82.3	7.5
	75.0	100.0	15.9	82.0	7.8
15th June	99.5	102.1	11.9	82.4	4.1
	99.0	101.3	12.3	82.1	4.6
	97.5	100.4	12.8	81.8	5.1
	95.0	99.8	13.2	81.6	5.4
	90.0	99.2	13.5	81.4	5.8
	75.0	98.3	14.0	81.1	6.3
1st July	99.5	95.2	6.3	80.5	3.4
	99.0	94.5	7.0	80.2	3.6
	97.5	93.7	7.8	79.7	3.8
	95.0	93.0	8.4	79.3	3.9
	90.0	92.4	9.0	79.0	4.1
	75.0	91.4	10.0	78.4	4.3
15th July	99.5	95.2	10.0	83.8	4.1
	99.0	94.9	10.4	83.3	4.5
	97.5	94.4	10.9	82.7	5.0
	95.0	94.0	11.3	82.3	5.4
	90.0	93.6	11.7	81.8	5.7
	75.0	93.1	12.3	81.2	6.3

Contd...

MADRAS CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st August	99.5	95.3	10.0	82.5	3.8
	99.0	94.6	10.5	81.8	4.1
	97.5	93.7	11.1	81.0	4.4
	95.0	93.1	11.6	80.4	4.7
	90.0	92.6	12.0	79.8	4.9
	75.0	91.8	12.6	79.0	5.3
15th August	99.5	95.8	9.1	81.0	3.7
	99.0	95.0	9.8	80.8	4.0
	97.5	94.1	10.6	80.5	4.5
	95.0	93.5	11.2	80.3	4.8
	90.0	92.8	11.8	80.1	5.2
	75.0	91.9	12.6	79.8	5.6
1st September	99.5	94.6	10.0	82.0	3.8
	99.0	94.2	10.6	81.8	4.3
	97.5	93.6	11.2	81.6	4.8
	95.0	93.1	11.7	81.5	5.2
	90.0	92.7	12.3	81.4	5.6
	75.0	92.0	13.0	81.2	6.2
15th September	99.5	92.5	7.6	82.6	2.9
	99.0	92.0	8.1	82.4	3.4
	97.5	91.3	8.7	82.0	4.1
	95.0	90.8	9.2	81.8	4.6
	90.0	90.3	9.6	81.5	5.1
	75.0	89.5	10.3	81.2	5.8

MANGALORE CITY

Date	Probability	Elements: Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st March	99.5	91.4	9.0	77.4	2.6
	99.0	91.0	9.6	77.2	2.9
	97.5	90.4	10.2	76.9	3.4
	95.0	90.0	10.7	76.7	3.7
	90.0	89.6	11.3	76.5	4.0
	75.0	88.9	12.1	76.2	4.6
15th March	99.5	91.9	7.7	78.1	2.9
	99.0	91.5	8.3	77.9	3.2
	97.5	90.9	9.2	77.7	3.5
	95.0	90.5	9.8	77.5	3.8
	90.0	90.0	10.5	77.4	4.0
	75.0	89.4	11.5	77.1	4.4
1st April	99.5	92.6	8.5	79.5	2.9
	99.0	92.3	8.9	79.3	3.1
	97.5	91.9	9.4	79.0	3.2
	95.0	91.6	9.8	78.8	3.4
	90.0	91.3	10.3	78.6	3.5
	75.0	90.8	10.9	78.3	3.8
15th April	99.5	91.2	7.2	80.2	1.9
	99.0	91.0	7.6	80.0	2.1
	97.5	90.7	8.2	79.7	2.3
	95.0	90.6	8.7	79.5	2.5
	90.0	90.4	9.2	79.3	2.8
	75.0	90.1	9.9	78.9	3.1
1st May	99.5	94.0	7.3	80.9	2.1
	99.0	93.5	7.8	80.7	2.4
	97.5	92.9	8.3	80.5	2.8
	95.0	92.5	8.7	80.3	3.0
	90.0	92.0	9.2	80.1	3.3
	75.0	91.3	9.8	79.9	3.7

contd...

MANGALORE CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
15th May	99.5	92.5	6.2	81.2	3.0
	99.0	92.0	6.7	81.0	3.3
	97.5	91.4	7.4	80.8	3.6
	95.0	91.0	8.0	80.7	3.8
	90.0	90.5	8.5	80.5	4.0
	75.0	89.9	9.3	80.3	4.4
1st June	99.5	89.0	6.3	81.7	2.2
	99.0	88.5	6.7	81.1	2.5
	97.5	87.7	7.1	80.4	2.8
	95.0	87.2	7.4	79.9	3.0
	90.0	86.6	7.7	79.3	3.3
	75.0	85.8	8.2	78.5	3.6
15th June	99.5	88.0	5.6	78.9	3.0
	99.0	87.3	6.0	78.7	3.2
	97.5	86.5	6.6	78.5	3.3
	95.0	85.9	7.0	78.3	3.5
	90.0	85.3	7.4	78.1	3.6
	75.0	84.5	8.0	77.8	3.8
1st July	99.5	85.9	2.2	79.9	2.6
	99.0	85.0	3.0	79.5	3.0
	97.5	84.0	4.0	79.0	3.5
	95.0	83.3	4.6	78.7	3.8
	90.0	82.6	5.3	78.4	4.1
	75.0	81.6	6.2	78.0	4.6
15th July	99.5	85.7	3.4	78.9	2.1
	99.0	85.3	3.9	78.7	2.4
	97.5	84.7	4.5	78.4	2.7
	95.0	84.3	5.0	78.2	3.0
	90.0	83.8	5.4	78.0	3.2
	75.0	83.2	6.0	77.8	3.6

Contd..

MANGALORE CITY

Date	Probability	Elements: Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st August	99.5	83.5	2.9	77.7	1.5
	99.0	83.0	3.3	77.5	1.8
	97.5	82.3	3.8	77.2	2.2
	95.0	81.9	4.1	77.0	2.6
	90.0	81.4	4.5	76.8	2.9
	75.0	80.4	5.0	76.5	3.3
15th August	99.5	83.5	3.0	78.3	2.6
	99.0	83.0	3.3	78.1	2.8
	97.5	82.4	3.8	77.8	3.1
	95.0	82.0	4.2	77,6	3.2
	90.0	81.5	4.5	77.3	3.4
	75.0	80.8	5.1	77.0	3.7
1st September	99.5	85.6	4.7	78.6	2.2
	99.0	85.2	5.1	78.4	2.4
	97.5	84.7	5.6	78.1	2.6
	95.0	84.3	6.0	77.9	2.8
	90.0	83.9	6.4	77.7	3.0
	75.0	83.3	7.0	77.4	3.3
15th September	99.5	85.1	4.2	78.5	2.8
	99.0	84.6	4.7	78.3	3.1
	97.5	84.0	5.4	78.0	3.6
	95.0	83.6	5.9	77.8	4.0
	90.0	83.1	6.4	77.6	4.3
	75.0	82.4	7.2	77.3	4.9

NAGPUR CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st March	99.5	97.1	23.1	68.7	7.0
	99.0	96.5	23.7	68.1	7.4
	97.5	95.7	24.5	67.3	8.0
	95.0	95.1	25.1	66.6	8.4
	90.0	94.4	25.8	66.0	8.9
	75.0	93.5	26.7	65.0	9.5
16th March	99.5	102.7	10.1	71.7	5.8
	99.0	101.7	20.4	70.7	6.8
	97.5	100.6	21.9	69.5	8.0
	95.0	99.8	22.9	68.6	8.9
	90.0	99.1	23.9	67.8	9.7
	75.0	98.0	25.3	66.6	10.8
1st April	99.5	104.5	21.2	69.0	5.0
	99.0	103.6	21.7	68.5	6.1
	97.5	102.5	22.4	68.0	7.4
	95.0	101.8	22.9	67.6	8.3
	90.0	101.0	23.4	67.1	9.3
	75.0	99.9	24.2	66.6	10.6
16th April	99.5	104.6	14.4	75.9	6.8
	99.0	103.7	15.8	76.5	7.6
	97.5	102.6	17.5	72.8	8.6
	95.0	101.8	18.7	71.6	9.2
	90.0	101.1	19.8	70.4	9.9
	75.0	100.1	21.4	68.8	10.8
1st May	99.5	110.5	18.4	72.7	6.3
	99.0	109.7	19.0	72.2	7.3
	97.5	108.6	19.8	71.7	8.6
	95.0	107.8	20.4	71.2	9.5
	90.0	106.9	21.0	70.8	10.5
	75.0	105.7	21.8	70.1	11.9

contd...

NAGPUR CITY

Date	Probability	Elements			
		Dry. bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
16th May	99.5	111.9	13.7	85.5	4.0
	99.0	110.4	14.9	83.9	4.9
	97.5	108.6	16.4	81.8	6.0
	95.0	107.3	17.5	80.4	6.8
	90.0	106.0	18.6	78.9	7.6
	75.0	104.1	20.1	76.8	8.7
1st June	99.5	109.7	18.0	75.9	5.0
	99.0	109.3	18.5	75.4	5.8
	97.5	108.8	19.0	74.7	6.8
	95.0	108.5	19.4	74.2	7.6
	90.0	108.1	19.9	73.6	8.3
	75.0	107.6	20.5	72.9	9.4
16th June	99.5	108.5	13.6	77.4	2.3
	99.0	107.2	14.4	77.1	3.1
	97.5	105.7	15.3	76.7	3.9
	95.0	104.6	16.0	76.4	4.6
	90.0	103.5	16.7	76.2	5.2
	75.0	102.1	17.6	75.8	6.0
1st July	99.5	92.7	7.7	84.2	3.1
	99.0	92.1	8.3	83.0	3.5
	97.5	91.4	9.1	81.6	3.9
	95.0	90.8	9.7	80.5	4.1
	90.0	90.3	10.3	79.4	4.4
	75.0	89.5	11.2	77.8	4.9
16th July	99.5	101.2	3.4	81.1	2.1
	99.0	97.5	0.6	80.0	2.5
	97.5	93.6	2.3	78.8	2.8
	95.0	91.2	4.0	78.0	3.0
	90.0	89.1	5.5	77.4	3.2
	75.0	86.6	7.4	76.6	3.4

contd..

NAGPUR CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st August	99.5	89.0	1.2	78.5	1.9
	99.0	88.0	2.1	78.2	2.1
	97.5	86.8	3.2	77.8	2.3
	95.0	85.9	4.1	77.5	2.5
	90.0	85.1	4.9	77.2	2.6
	75.0	83.8	6.1	76.7	2.9
15th August	99.5	89.9	2.9	81.9	1.2
	99.0	88.9	3.8	81.2	1.7
	97.5	87.7	4.8	80.4	2.4
	95.0	86.9	5.5	79.8	2.9
	90.0	86.1	6.3	79.3	3.3
	75.0	85.0	7.3	78.5	4.0
1st September	99.5	92.9	2.7	83.4	2.2
	99.0	91.6	4.1	82.1	2.5
	97.5	90.2	5.7	80.6	2.9
	95.0	89.2	6.8	79.7	3.1
	90.0	88.3	7.8	78.8	3.3
	75.0	87.2	9.1	77.6	3.6
15th September	99.5	90.8	3.9	79.7	2.3
	99.0	89.8	4.7	79.2	2.6
	97.5	88.6	5.6	78.5	2.9
	95.0	87.7	6.3	78.0	3.2
	90.0	86.8	7.0	77.6	3.5
	75.0	85.5	8.0	76.9	3.9

TIRUCHIRAPALLI CITY

Date	Probability	Elements: Dry bulb temperature	Elements: Dry bulb temperature range	Elements: Wet bulb temperature	Elements: Wet bulb temperature range
1st March	99.5	95.9	14.3	79.6	3.1
	99.0	95.5	15.2	78.8	3.6
	97.5	95.0	16.2	77.9	4.2
	95.0	94.6	17.0	77.3	4.7
	90.0	94.3	17.7	76.7	5.1
	75.0	93.8	18.7	75.9	5.7
15th March	99.5	94.9	17.0	78.3	5.7
	99.0	94.8	17.6	77.8	5.9
	97.5	94.6	18.3	77.2	6.2
	95.0	94.4	18.9	76.8	6.4
	90.0	94.2	19.4	76.3	6.7
	75.0	94.0	20.3	75.5	7.0
1st April	99.5	99.2	15.5	78.8	0.9
	99.0	98.8	16.1	78.5	1.7
	97.5	98.4	16.9	78.2	2.7
	95.0	98.1	17.5	78.0	3.4
	90.0	97.8	18.1	77.8	4.0
	75.0	97.4	18.8	77.5	4.9
15th April	99.5	102.1	15.3	81.0	3.9
	99.0	101.5	15.7	80.8	4.5
	97.5	100.8	16.2	80.4	5.2
	95.0	100.2	16.6	80.2	5.7
	90.0	99.7	17.0	80.0	6.2
	75.0	98.9	17.5	79.6	7.0
1st May	99.5	102.9	14.3	80.4	2.0
	99.0	102.1	15.0	80.1	2.8
	97.5	101.2	15.7	79.7	3.8
	95.0	100.5	16.3	79.4	4.5
	90.0	99.9	16.8	79.2	5.1
	75.0	99.1	17.5	78.8	6.1

contd..

TIRUCHIRAPALLI CITY

Date	Probability	Elements: Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
15th May	99.5	105.2	8.1	83.6	1.9
	99.0	103.6	9.3	83.0	2.7
	97.5	101.7	10.8	82.3	3.7
	95.0	100.3	11.8	81.8	4.4
	90.0	99.0	12.9	81.3	5.1
	75.0	97.0	14.4	80.5	6.1
1st June	99.5	100.1	14.5	79.4	4.3
	99.0	99.7	15.0	79.1	4.6
	97.5	99.3	15.5	78.8	5.0
	95.0	99.0	15.9	78.5	5.3
	90.0	98.7	16.3	78.3	5.7
	75.0	98.2	16.9	77.9	6.1
15th June	99.5	101.2	9.7	79.0	4.0
	99.0	100.4	10.4	78.6	4.2
	97.5	99.3	11.4	78.1	4.5
	95.0	98.6	12.0	77.8	4.7
	90.0	97.8	12.7	77.4	5.0
	75.0	96.7	13.7	76.9	5.3
1st July	99.5	95.1	11.3	78.6	4.5
	99.0	94.7	11.6	78.1	4.6
	97.5	94.4	12.0	77.6	4.8
	95.0	94.1	12.3	77.2	4.9
	90.0	93.8	12.6	76.8	5.1
	75.0	93.4	13.0	76.2	5.3
15th July	99.5	97.3	10.6	78.9	4.3
	99.0	96.8	11.1	78.5	4.5
	97.5	96.2	11.9	78.0	4.8
	95.0	95.7	12.4	77.6	4.9
	90.0	95.2	12.9	77.2	5.1
	75.0	94.5	13.8	76.6	5.4

contd..

TIRUCHIRAPALLI CITY

Date	Probability	Elements			
		Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st August	99.5	99.1	10.8	77.8	2.7
	99.0	98.4	11.4	77.3	3.1
	97.5	97.4	12.2	76.7	3.7
	95.0	96.8	12.8	76.3	4.0
	90.0	96.2	13.3	75.9	4.4
	75.0	95.3	14.1	75.4	4.9
15th August	99.5	95.0	11.6	78.1	3.7
	99.0	94.8	11.9	77.8	4.0
	97.5	94.4	12.3	77.4	4.5
	95.0	94.2	12.7	77.1	4.8
	90.0	93.9	13.0	76.8	5.2
	75.0	93.5	13.5	76.3	5.7
1st September	99.5	97.5	14.1	78.7	1.9
	99.0	97.0	14.5	78.2	2.3
	97.5	96.4	15.0	77.6	2.8
	95.0	96.0	15.3	77.2	3.2
	90.0	95.6	15.6	76.8	3.5
	75.0	95.0	16.1	76.3	3.9
15th September	99.5	96.2	10.6	79.3	3.4
	99.0	95.5	11.2	78.8	3.7
	97.5	94.8	11.9	78.2	4.1
	95.0	94.2	12.4	77.8	4.4
	90.0	93.7	12.9	77.4	4.7
	75.0	93.0	13.6	76.9	5.0

TRIVENDRUM CITY

Date	Probability	Elements: Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
1st March	99.5	91.8	7.7	79.5	1.6
	99.0	91.2	8.3	79.1	2.1
	97.5	90.5	9.0	78.7	2.8
	95.0	90.0	9.4	78.3	3.2
	90.0	89.5	9.9	78.0	3.6
	75.0	88.9	10.6	77.5	4.2
15th March	99.5	93.7	6.7	79.7	0.6
	99.0	93.1	7.8	79.2	1.5
	97.5	92.4	9.2	78.5	2.6
	95.0	91.8	10.2	78.0	3.4
	90.0	91.3	11.1	77.6	4.1
	75.0	90.7	12.4	77.0	5.1
1st April	99.5	91.6	7.9	83.1	0.1
	99.0	91.2	8.5	82.4	0.5
	97.5	90.7	9.3	81.5	1.3
	95.0	90.5	9.7	80.9	1.7
	90.0	90.2	10.2	80.4	2.2
	75.0	89.8	10.7	79.6	2.8
15th April	99.5	90.7	6.4	82.2	1.7
	99.0	90.4	7.0	81.8	2.3
	97.5	90.0	7.8	81.3	3.0
	95.0	89.8	8.3	81.0	3.5
	90.0	89.5	8.9	80.6	4.0
	75.0	89.1	9.7	80.1	4.8
1st May	99.5	94.6	5.1	80.9	1.1
	99.0	93.5	6.0	80.6	1.6
	97.5	92.3	7.0	80.1	2.1
	95.0	91.4	7.3	79.8	2.5
	90.0	90.6	8.5	79.6	2.9
	75.0	89.4	9.5	79.2	3.4

Contd...

TRIVENDRUM CITY

Date	Probability	Elements: Dry bulb temperature	Dry bulb temperature range	Wet bulb temperature	Wet bulb temperature range
15th May	99.5	91.4	4.7	79.9	1.8
	99.0	90.6	5.4	79.6	1.7
	97.5	89.6	6.2	79.3	2.3
	95.0	88.8	6.8	79.1	2.7
	90.0	88.1	7.4	78.8	3.1
	75.0	87.0	8.2	78.5	3.6
1st June	99.5	92.1	4.3	80.3	0.5
	99.0	90.9	5.0	79.9	1.1
	97.5	89.7	5.9	79.4	1.7
	95.0	88.8	6.4	79.1	2.2
	90.0	88.0	6.9	78.8	2.6
	75.0	86.9	7.6	78.4	3.2
15th June	99.5	90.0	1.8	80.3	0.3
	99.0	88.8	2.9	79.7	0.4
	97.5	87.6	4.0	79.1	1.1
	95.0	86.7	4.8	78.7	1.6
	90.0	86.0	5.5	78.3	2.0
	75.0	84.9	6.5	77.8	2.7
1st July	99.5	88.4	3.4	80.8	0.1
	99.0	87.6	4.3	80.2	0.7
	97.5	86.7	5.4	79.6	1.7
	95.0	86.1	6.1	79.1	2.3
	90.0	85.5	6.8	78.7	2.9
	75.0	84.8	7.7	78.2	3.7
15th July	99.5	86.5	4.5	77.8	1.2
	99.0	85.9	5.1	77.5	1.6
	97.5	85.1	5.9	77.2	2.1
	95.0	84.6	6.5	77.0	2.4
	90.0	84.0	7.0	76.7	2.8
	75.0	83.3	7.8	76.4	3.2

Contd...

TRIVENDRUM CITY

Date	Probability	Elements: Dry bulb temperature	Elements: Dry bulb temperature range	Elements: Wet bulb temperature	Elements: Wet bulb temperature range
1st August	99.5	84.9	5.6	78.2	2.1
	99.0	84.6	5.9	77.9	2.4
	97.5	84.2	6.3	77.7	2.7
	95.0	84.0	6.6	77.5	2.9
	90.0	83.7	6.9	77.3	3.1
	75.0	83.3	7.4	77.0	3.4
15th August	99.5	84.4	5.5	79.3	1.9
	99.0	84.1	5.9	78.9	2.4
	97.5	83.9	6.3	78.4	2.9
	95.0	83.7	6.6	78.1	3.3
	90.0	83.5	6.9	77.8	3.6
	75.0	83.2	7.3	77.4	4.1
1st September	99.5	86.9	4.1	78.7	2.0
	99.0	86.4	4.8	78.5	2.3
	97.5	85.8	5.7	78.2	2.7
	95.0	85.4	6.3	78.0	2.9
	90.0	85.0	6.9	77.8	3.2
	75.0	84.4	7.7	77.5	3.5
15th September	99.5	87.6	6.7	78.7	1.7
	99.0	87.1	7.1	78.5	2.1
	97.5	86.6	7.5	78.1	2.5
	95.0	86.2	7.9	77.9	2.8
	90.0	85.8	8.2	77.6	3.1
	75.0	85.2	8.5	77.3	3.6

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